THE ONTARIO PUBLIC SCHOOL HYGIENE

AUTHORIZED BY
THE MINISTER OF EDUCATION FOR ONTARIO

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THE ONTARIO

PUBLIC SCHOOL HYGIENE

REVISED EDITION

BY

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Authorized by the Minister of Education for Ontario

FOR USE IN

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PREFACE

The first edition of this book appeared in 1910. Since then some of its matter has become out-of-date. On the other hand, important additions have been made to our knowledge of physiology and hygiene, and these additions, in so far as they can be understood by children, have been incorporated in the revised text.

The additional space required for the new matter has been found by the omission of some of the anatomy and physiology,—subjects, which according to the testimony of many public school teachers, are too difficult, and unsuitable for school children.

For school children the important matter is hygiene—a knowledge of the laws of health. If, during their school days, children learn how to care for their health and acquire health habits, as they certainly should, they are laying the best possible foundation for doing their daily work with real enjoyment and for bearing the stress and strain of adult life without danger of a physical or mental breakdown.

An example of the advance which has been made in the teaching of hygiene may be found in the chapters devoted to the classification of the communicable diseases. The classification is so simple that any child can learn it more easily than he can the classification of words in grammar. No child can be taught how to distinguish one communicable disease from

another; but any child in Form IV can be taught how the communicable diseases are spread from person to person; and every child so taught will to some extent be put upon his guard against contracting one of these diseases.

In view of the importance of the temperance question, it has been thought advisable to discuss the effects of alcohol in the human body much more fully than in the first edition. Accordingly, the space devoted to this subject has been almost doubled.

The Ontario Oral Hygiene Committee furnished much of the matter that appears in the chapter on the *Teeth*.

The author is greatly indebted to Dr. R. D. Defries, of the Pathological Department of Toronto University, for the time and labour which he has spent so generously in assisting this edition through the press.

Acknowledgment is also due to James Cappon, LL.D., Professor of English Language and Literature in Queen's University, for his kindness in reading the page proofs.

Other professors of Queen's who have assisted in the preparation of this edition are Dean Connell, who read the proofs of the chapters on the *Throat* and the *Special Senses*; Professor James Third, M.B. (Tor.), who read those on the *Skin* and on *Tuberculosis*; and Dr. W. T. Connell, Professor of Pathology and Sanitary Sciences, who read the whole book. The Rev. M. Macgillivray, M.A., D.D., also read all of the proofs.

A. P. K.

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CHAPTER I

WHAT FRESH AIR CONTAINS

In foggy weather it is easy to see that water is one of the substances in air, because the face and clothing become wet. But in clear weather it is not so easy to see that there is water in air, and yet there must be. We know that rain-water in a tub outside soon dries up; and the water can go nowhere else than into the air, where it is invisible.

Moreover, this invisible water may be withdrawn from the air and made visible again. This is seen in summer when fine drops of water collect upon the sides of a pitcher which holds ice-cold water. People who do not know where these drops come from say that the pitcher sweats. This of course is not correct. For if the water could pass through little pores to the outside of the pitcher when it holds ice-cold water, then water should pass through these same pores when the pitcher holds warm water. But it does not.

The fact is that these drops on the outside are formed from tiny particles of water in the air which surrounds the pitcher. When the air is cooled, these particles come

together and form little drops. Dew, rain, and the frost which forms on window panes in winter, all come from the water in the air,—water not in the form in which we see it in wells, rivers, and lakes, but water in the form of invisible particles.

What other substances does air contain? Let us try to obtain an answer to this question by performing the following experiments:

Put a lump of quicklime, about as large as a hen's egg, into a quart fruit jar. Pour in water until the jar is about three-quarters full, shake it well, and allow it to stand for a few hours. By this time clear water has collected at the top, and lime is lying at the bottom. This clear water is known as lime-water. Without shaking the jar pour some of the lime-water into a small goblet or cup.

Now take a bicycle pump, or a rubber bulb syringe, and placing the end of it in the goblet of lime-water, force some of the air of the school-room through it. In the course of a minute or two, if the air in the room is very stuffy, the lime-water will gradually turn a milky colour.

Take about a half-glass of the lime-water. Now, placing one end of a glass tube, a rubber tube, or a straw in this lime-water, and taking the other end in your mouth, force air from the lungs through it. This time the milky colour appears almost immediately.

Try the experiment again with more lime-water, but in this case carry the goblet outside of the school-house,

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Note.—The teacher should arrange to teach the lessons on the composition of the air, on oxygen, and on carbon dioxide, before taking up Chapters I, II, III, and IV, of the Hygiene. Consult *Nature Study Manual*, pages 252, 253, and 254.

and force fresh air through it by means of the rubber bulb syringe. Notice how much longer it now takes, that is, how much more air must be passed into the lime-water before the milky colour appears.

These experiments prove to us that besides the water there is another substance in air. This second substance, like the water, is invisible and turns lime-water a milky colour. It is present in fresh air in small quantity; more of it is present in the air of the school-room ; and still more of it in the air which comes from our lungs. It is known as carbon dioxide.

Then, further, the air contains oxygen—that invisible substance which is so important to our breathing. We could not live much longer than five minutes without oxygen. If it were not for this gas every animal on earth would soon die. And it is this substance which makes our fires, lamps, and candles burn. Without it they would go out at once.

A fourth substance which is present in very large quantity in the atmosphere is known as nitrogen. So far as we know at present this gas has no effect upon health either one way or the other. It has neither colour, taste, nor smell, and will not keep us alive as oxygen does. On the contrary, if we were placed in an atmosphere of nitrogen we should soon die; and if a burning candle were placed in nitrogen gas it would at once go out. Just because there is about four times as much nitrogen in the air as there is oxygen, the nitrogen dilutes the oxygen and lessens its activity in making substances burn.

Ammonia is another substance which is always present in air. Boys and girls who have happened to go near a

fresh manure heap must sometimes have recognized the peculiar odour of this gas. It is formed from the decay of animal and vegetable matter, and is, therefore, a constant constituent of the atmosphere.

We may now set down the composition of the atmosphere in the form of a table:

Oxygen...........	20.94 volumes out of 100.
Nitrogen..........	78.09 volumes out of 100.
Carbon Dioxide.....	.03 volumes out of 100.
Argon..............	.94 volumes out of 100.
Water vapour	a very variable quantity in 100 volumes.

Dust in varying quantities.

Mere traces of six other substances.

CHAPTER II

HOW FRESH AIR IS SPOILED

How does fresh air become impure and therefore unfit to breathe?

Generally speaking, the air of the country is rarely spoiled. To be sure, it sometimes happens that, when fires are raging over large areas of woodland country, the atmosphere does perhaps for some weeks become spoiled by smoke; but apart from an accident like this the mass of the country air, that is, the atmosphere, is never spoiled.

It is different, however, in cities and towns, especially those in which there is much street traffic and where

many shops and factories burn coal. Here the atmosphere becomes filled with smoke, dust, and frequently fine particles of filth, and the air becomes spoiled to some extent.

Inside the shops, factories, and homes of the inhabitants, the air is still more spoiled, because, in addition to the outside impurities, there are found those which come from the lungs of the inmates and from the candles, lamps, or gas jets with which the houses are lighted. Of these three modes of lighting, candles and lamps pollute the air most of all. Coal-gas, if pure and conveyed in pipes that do not leak, spoils the air of a building to only half the extent that lamps and candles do, while furnishing the same amount of light. Electric lights do not pollute the air at all. The smaller the houses and the more stagnant the air, the worse it becomes.

Contrary to popular belief, it is almost impossible to spoil the air by reducing the amount of oxygen or increasing the amount of carbon dioxide. Only when the oxygen in the air is decreased to about twelve per cent., or the carbon dioxide increased to about five per cent. does breathing become altered. Under either of these conditions we pant for breath, but neither of these conditions occur in even the worst ventilated houses. In short, nature has provided that even extreme variations in the quantity of oxygen and carbon dioxide may occur in the air we breathe without doing any damage to health.

Air is impaired by tobacco smoke, by the odour of burnt food, by decaying garbage, by filthy outbuildings and yards, by bad cellars and drains, by disagreeable

odours, especially from the feet of people who do not bathe frequently, and by odours from the clothing, bedding, or floors and walls of houses that are not kept clean.

When the teeth, mouth, nose, and throat are all perfectly healthy, the breath has no disagreeable odour, and the air that passes out of the lungs, commonly called the expired air, is not spoiled. But when these organs are diseased, then there are added to expired air fine particles of matter which are not only disagreeable to the sense of smell of other people, but which sometimes cause these to lessen the amount of air which they would otherwise breathe.

Then, again, the dirt which gathers upon clothing, and upon the outer skin of persons who do not bathe frequently, is usually in a state of decay, and gives rise to odours that are quite as disagreeable and harmful to health as are the odours from a diseased mouth, nose, or throat.

Lastly, there are many dust particles in the air of schools, churches, and public buildings. This dust is usually made up of fine particles of soil, soot, scales of skin, hair, bits of wool, cotton, or linen, and microbes or germs of animals and plants, so small that they cannot be seen with the naked eye. In schools, when proper care is not taken, the dust is largely increased by the particles of chalk which are brushed from the blackboards, especially when this is not carefully done.

NOTE.—The matter which comes from the nose, throat, windpipe, skin, and lungs, as well as all other matter which comes from animals or plants, is usually spoken of as organic matter.

Of course, the air in public buildings does not change suddenly from being fresh air into being stuffy air. The change is a very gradual one. At 9 a.m. the air in many a school-room is no doubt perfectly fresh; an hour or two afterwards it may be very stuffy. Whether it is so or not will depend upon the ventilation of the room.

We can nearly always tell by the smell of air whether it is fit to breathe. If it smells musty or stuffy or has a disagreeable odour, it is unfit to breathe. It may not do a person much harm to breathe bad-smelling air for a short time. If he is strong, he will soon get accustomed to the bad odour and will not mind it much; but, if he lives for some years in such air, he may be quite sure that it will slowly undermine his strength. It is the little harm which bad air keeps doing to us daily for years that at last breaks down health, and it is because of this that employees in shops and factories have a right to insist upon getting an abundant supply of moving, pure, fresh air.

CHAPTER III

FLOATING MATTER IN AIR

Even when the school furniture has been fairly well dusted, you can always detect some dust on it by simply wiping the surface with a clean white cloth.

Where does this dust come from? You tell me at once that it comes from out-of-doors, and that it consists of powdered earth or stone which has been brought in on

the pupils' shoes, especially when the roads are muddy. That is what Professor Tyndall thought in 1868, when he first examined the floating matter in the air of his laboratory in London. But to his surprise he found that much of this matter is composed of fine little particles which must have come from animals and plants; because, when he passed them through the flame of a spirit-lamp they burned up completely, which they would not have done if they had been composed of earth or stone only.

Later on in his studies he had dust from the walls of the British Museum examined, and then he discovered that about half of it was composed of earthy matter, which, being somewhat heavy, had soon settled down on floors and walls; whereas the other half consisted of very fine and very light particles, which had floated about in the air. Since every substance must be of animal, vegetable, or mineral origin, Tyndall concluded that the lighter inflammable particles must have come from plants or animals and that the heavier earthy matter must have been carried from the streets on the shoes of students or visitors.

Nearly ten years before Tyndall began his experiments, Louis Pasteur had studied the composition of air and had come to the conclusion that everywhere it contains microbes or the germs of animal and plant life. He reached this conclusion from studying the souring of milk, the fermentation of wines, and the putrefaction, or decay, of flesh; for it seemed to him that all three were due to the action of these microbes.

Up to 1860 it was generally believed that, when animal or vegetable matter began to decay, there came into life, in the very act of decay, an immense number of tiny animals or plants. These living animals were believed to have sprung from dead ones. This springing into life of new forms out of dead or decaying matter was known as "spontaneous generation".

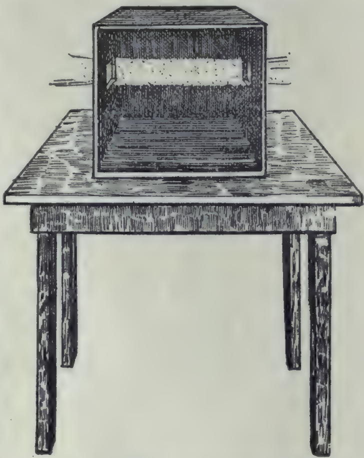


FIGURE 1.—Beam of light showing floating matter in the air of a box.

After Tyndall had read of Pasteur's experiments, it occurred to him that possibly some of these germs were to be found among the floating particles in the air of the Royal Institution, London, where he lectured. Such particles he had often noticed when a strong beam of light was passed through a darkened tube, box, or room. Unless air is unusually pure, the path of a sunbeam is always clearly marked out by a large number of dust particles moving up and down and backwards and forwards. They can generally be noticed when a magic lantern is lighted in a dark room.

You may yourself repeat some of the experiments made by Pasteur and Tyndall to find out the nature of these germs, if you will prepare a vegetable infusion as follows:

Wash a turnip thoroughly in clean water, cut it into thin slices, and place it in a saucepan with just enough water to cover it. Allow the whole to stand for four or five hours in a warm room. The liquid, when filtered through several sheets of filtering paper or folds of well-boiled linen, will be as clear as pure water and is known as "turnip infusion".

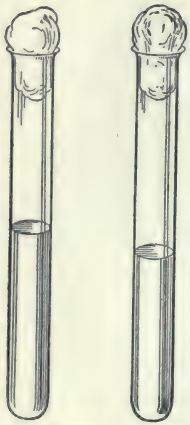


FIGURE 2.—Two test-tubes containing infusions that have been "sterilized" by boiling.

If now two test-tubes be half-filled with this infusion, plugged with what is known as sterile cotton wool, and boiled for five minutes by holding their lower ends in the upper part of the flame of a spirit-lamp, the boiling will have killed all the germs that are in the liquid and in the air in the tubes above it.

If, after cooling, the cotton plug be removed for a moment from one of the tubes, and the liquid be merely touched with a needle that has been rubbed against any object in the room, the plug being again replaced, it will be found after a time that, while the liquid in this tube has turned cloudy, that in the unopened tube has remained perfectly clear and unchanged.

In Tyndall's experience, the infusions usually went bad in from three to five days, depending upon where they were placed, and especially upon the temperature at which they were kept.

Of course, the apparatus which Prof. Tyndall used was not so simple as that described above. It was much

more elaborate. But anybody who can procure such simple articles as two test-tubes, some sterile cotton batting, and a spirit-lamp, can verify for himself Pasteur's and Tyndall's conclusions about germs growing in infusions and their being killed by boiling.

Tyndall used many different kinds of infusions—mutton, fowl, hops, tea, fish,—but always found that when the infusions were exposed to air, absolutely free from dust, as tested by a beam of light, none ever went bad. They never turned sour or lost their clear colour. On the other hand, all such infusions went bad when exposed to ordinary air.

Tyndall's experiments all pointed to the same conclusions as Pasteur's, namely, that the purest air is found upon mountains, less pure air upon woodland heights, less pure air still in level farming districts, and the most impure air in crowded and dirty cities and towns.

As a result of experiments which were carried on in nearly 10,000 different vessels, Tyndall classified the germs in the air according to their power of resisting heat:

1. Those killed under the boiling point of water.
2. Those killed in five minutes' boiling.
3. Those not killed in five minutes, but killed in fifteen.
4. Those not killed in fifteen, but killed in thirty.
5. Those not killed in thirty, but killed in an hour.
6. Those not killed in one, but killed in two hours.
7. Those not killed in two, but killed in three hours.
8. Those not killed in three, but killed in four hours.
9. Those killed by boiling over four hours.

Since Tyndall did his splendid work, it has been discovered that there are produced in the inside of some microbes, very, very small, clear, rounded bodies which are known as "spores", and that these spores are much harder to kill than the parent germ. The method to-day of sterilizing infusions containing spores is the same as Tyndall finally practised, namely, to boil the infusion for a few minutes, then allow it to stand for eight or ten hours, and boil again. Boiling and cooling in this way for a number of times will sterilize the most resistant of known spores or germs.

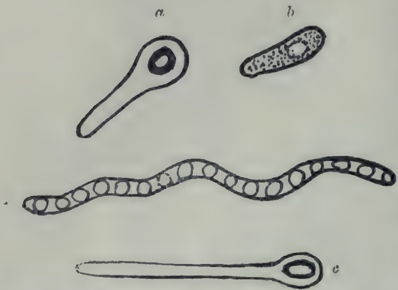


FIGURE 3.—Spores inside of a Spiral Bacterium *A*. Three escaped ones *a*, *b*, *c*, have started to grow.

The explanation of the effects of boiling several times at intervals seems to be that, after the first boiling, the spores which have not yet been sterilized start to grow. Before they have had time to become fully grown and to cause putrefaction in the infusion, they are boiled a second time, and this kills all the spores which have sprouted, as they are easily killed when in this condition. Subsequently, other spores sprout, and they, too, are killed by the third boiling, and so on until all are killed.

Dust and microbes are always found together. Of the thousands of different kinds of microbes or germs which are known to exist in water, earth, air, or on plants and

animals, only a very small number cause disease in human beings. The majority of them are tiny plants, the remainder are tiny animals. The plant forms are spoken of as "bacteria", and the animal forms as "protozoa". Inasmuch as certain bacteria and protozoa live in or on human beings and animals, they are sometimes spoken of as parasitic plants and parasitic animals, respectively. The great majority of all bacteria are harmless and many, indeed, are essential to life.

CHAPTER IV

EFFECTS OF BAD AIR

Do people who live in bad air suffer more from ill-health than those who live in fresh air? We can answer this question most satisfactorily by watching the effects of bad air upon those who have to breathe it.

Perhaps one of the most terrible instances of this was seen in the prison known as the Black Hole of Calcutta. One hundred and forty-six persons were shut up over night in a cell twenty feet square provided with no means of ventilation except two small windows. So poisonous did the air become that one hundred and twenty-three died during the night.

But the effects of bad air are not often so sudden and so dreadful. Usually they are very gradual but none the less deadly. To make this clear, let us look at

some statistics of the deaths from consumption which occur among soldiers who live in barracks. These men are all examined by a doctor before they are allowed to join the army. They are well-fed, well-clad, get regular exercise, live regular lives, and they should, therefore, continue in good health for a long time. Moreover, the rooms in which they live and sleep are all kept clean.

Of course, not all barracks are of the same size. For example, a few years ago the soldiers in the British Foot Guards had an air space of 331 cubic feet per man; whereas those in the Horse Guards had 572 cubic feet per man. In other respects both classes of soldiers had the same accommodation.

We might expect that disease and death would visit both classes alike. But such was not the case. Looking at this one disease of consumption only, we find that the deaths among the Foot Guards amounted to 14 in every 1,000 soldiers; whereas the deaths from this disease among the Horse Guards amounted to only 7 in every 1,000 men.

How is this difference to be accounted for? There appears to be only one explanation. Although the air in both barracks was stagnant and the ventilation bad, yet the higher death-rate among the Foot Guards was undoubtedly due in part to the bad air, and in part to the overcrowding and the consequent ease with which any infectious disease like consumption or diphtheria could spread from person to person.

The fact that some occupations are less healthful than others, just because of bad air, seems to be borne out

by the high death-rate among barbers, hairdressers, dressmakers, seamstresses, school teachers, printers, and pressmen. The death-rate among these varies from 385 to 398 per 1,000 of those who die of all diseases, as compared with a rate of 121 to 136 among lawyers, doctors, and clergymen. There can be little doubt that the true explanation of these high death-rates is the impure air, lack of sunshine, and long hours of confinement—which all tend to undermine the strength and render one liable to catch some infectious disease.

There are certain occupations which are always carried on in dusty places, such as grinding grain and making flour; spinning and weaving cotton goods; making oil-cloth and linoleum; crushing, drilling, and polishing stone; and cutting glass. Our laws require that the health of those who work in such industries must be safe-guarded by the use of special ventilating systems. In some of these trades it is also necessary for the worker to wear a mask or respirator over his mouth and nose, and so prevent breathing much of the dust. The hours of labour in such work should be short, and the workers should spend much of their spare time in the fresh air and sunshine.

When dusty air is breathed for a long time, some of the particles stick to the surface of the little air sacs of the lungs and prevent the air from passing freely into the blood. The result is that people who have to breathe such air suffer in health and do not live so long as those who spend their lives in an outdoor occupation.

You may understand how dust can choke up our lungs, if you look at the older and lower leaves of a buttercup or dandelion. These leaves become covered with dust and in time die, partly from the effect of the dust, partly from the shading. The dust covers over the tiny little openings on the leaves, so that they cannot breathe properly. To remedy this, the plant keeps growing new leaves above the old ones, and these new leaves can always take in enough air to keep the plant alive. Unfortunately for us, we are not able to grow new lungs whenever we may happen to need them.

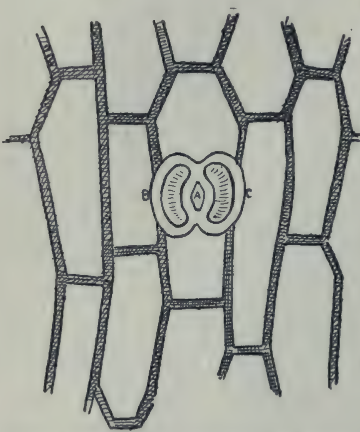


FIGURE 4.—One of the mouths on the under surface of a leaf. *A*, opening into the leaf. *B* and *C*, cells that guard the opening at *A*.

It is generally believed that the high death-rate which prevails in small houses is due to lack of fresh air, but the truth is that other causes, such as lack of clothing, lack of proper food, bodily weakness, and especially the ease with which disease germs spread from person to person in crowded rooms, help to produce the high death-rate.

CHAPTER V

TEMPERATURE AND HUMIDITY OF THE AIR

Besides its composition, there are two other facts about air which must be considered if we wish to take care of our health. These are its temperature and its humidity.

The temperature of the air is measured by the thermometer. There should be one of these instruments in every school-room, and no doubt you have seen one. When the air gets warmed as it does by the sun during the day, we say its temperature rises; and when the air loses heat as it does at night, we say that its temperature falls. So, too, its temperature varies greatly in summer from what it is in winter.

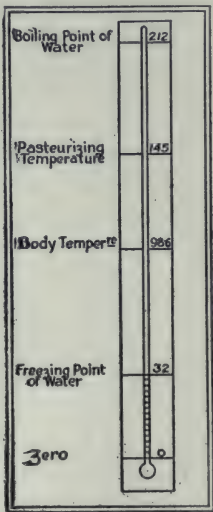


FIGURE 5.—Thermometer.

If a man is strong he can adapt himself to wide variations in temperature. For example, a workman has sometimes to endure a heat of 200 degrees F. near a furnace; while an explorer in the frigid zone may have to endure a cold of from 50 degrees F. to 70 degrees F. below zero. How is it that a man can withstand such variations? The answer is that his body produces more heat in cold surroundings and less heat in warm surroundings. But this

is not all. The fact is that the calm dry air which surrounds his body protects him from great cold; while moving dry air protects him from great heat; in other words, we may be said to wear a covering of air as well as a covering of clothes.

The effects of heat and of cold upon our bodies cannot be properly understood apart from a study of the amount of water vapour, always present in air. You will remember that in our study of the composition of the air, the statement was made that the quantity of water vapour, that is the humidity of the air, is very variable. One reason for this is that moisture is given off in the expired air of all air-breathing animals. An adult person gives off about four pounds of water vapour per day. About two and a half pounds come from the skin and one and a half pounds from the lungs. Moreover, all plants give off large quantities of water vapour from their leaves. Immense quantities also are evaporated from rivers, lakes, and oceans. It must be remembered also that warm air contains more moisture than cold. An increase of 27 degrees F. in temperature doubles the capacity of air for taking up vapour.

All these facts being kept in mind, it will readily be seen that in heating our houses the cold air which enters at, say freezing point, can take up far more moisture as soon as it is heated up to 68 or 70 degrees F. But most householders make no attempt to supply the additional water vapour required by this warmed air. The consequence is that this warmed dry air abstracts moisture from every article and every person in the room. Water, therefore, should be placed in pans on our radiators or in the hot-air flues from furnaces, so as to supply the

warmed air with the additional moisture which it requires. When this is not done, the dry air absorbs moisture from the nostrils, throat, and windpipe, thus irritating the surfaces of these organs and predisposing them to the growth of those bacteria which cause colds.

Extremes of heat and cold are much more trying to health when the air is full of moisture than when it is dry. It is a matter of common knowledge that we suffer more from heat in summer when the weather is "muggy", that is when the humidity is high, than when the humidity is low. And similarly, we suffer more from the cold when there is a strong breeze blowing and the air is laden with moisture.

Having thus studied the composition of the air, its temperature, and its humidity, you should now be prepared to answer the question: What is bad air and how does it produce its ill effects?

It was formerly believed that air becomes bad when the oxygen is decreased by breathing, and the carbon dioxide increased. But it has been proved that this is not the case. Dr. Leonard Hill placed eight students in a box about 120 inches long by 40 inches wide and 40 inches deep, and sealed it up tight so that no air could enter or leave it. "At the end of half-an-hour", he tells us, "they had ceased laughing and joking and their faces were congested. The carbon dioxide had increased to 3 or 4 per cent.; the oxygen had decreased to 16 or 17 per cent. Three electric fans were then turned on which merely whirled the air about just as it was in the box. The effect was like magic; the students at

once felt perfectly comfortable, but immediately the fans stopped they again felt as bad as before".

Only in very recent years has the true explanation of the ill effects of a vitiated atmosphere been discovered. Badly ventilated rooms always contain air that is calm, moist, and warm, and it has been proved by experiments somewhat similar to those of Dr. Hill's that such an atmosphere prevents loss of moisture from the skin and lungs, and consequently prevents loss of the heat from the body. This is the principal ill effect of bad air and is known as heat stagnation.

A second view taught by some great chemists was that poisons were given off in expired air, which when re-breathed caused sickness and even death. But this view also was disproved when it was discovered that fluid condensed from expired air had no effect upon healthy animals when it was injected into their bodies.

CHAPTER VI

VENTILATION

The carbon dioxide and the impurities in air that go with it can be kept down to the lowest limits only by replacing the stuffy air of a room with fresh air. The question of ventilation, therefore, is one of admitting sufficient air, of keeping it in gentle motion, and of keeping it moderately cool.

What makes air move? For one thing, heat has much to do with it. You can see this for yourselves by simply holding your hand some distance above a stove, a lighted lamp, or a hot-air register. In all three cases you can feel the hot air rising against your hand. The air is warmed by the lamp or stove, expands, becomes lighter than the surrounding cold air, and rises. The surrounding colder air presses in to take the place of the warm air which has risen. In its turn this air also is warmed, grows lighter, and rises in the path of the air which preceded it.

Figure 6.—Air moving upwards from a lighted lamp.

If we keep these facts in mind we shall not have much difficulty in understanding how some rooms become ventilated to a certain extent, even when they appear to be tightly closed up. For, all houses, since they cannot be made perfectly air-tight, allow some air to pass through the stone, brick, or frame walls, and through openings around windows and doors.

Moreover, when the outside door is opened, a rush of cold fresh air comes in through the lower part of the opening and a rush of stuffy air passes out through the upper part. In this way some ventilation takes place in every house. But such ventilation is very imperfect and never provides all the fresh air which a family requires. We must, therefore, plan our houses so that in winter the warm, moist, stagnant air shall escape through one opening and fresh air be admitted through some other opening.

How can this be done? One simple way is to arrange the window sashes so that the upper one can be lowered and the lower one raised. The stuffy air as it rises escapes at the top, and the fresh air comes in at the bottom. The objection to this is that those who are near the window may fear that they will catch cold from sitting in a draught.

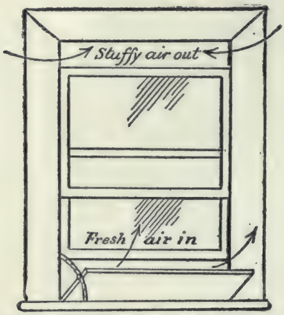


FIGURE 7.—Slanting board, arranged so that it can be adjusted to deflect the incoming draught upward. The upper sash lowered, the lower sash raised.

It is perhaps necessary to explain in this connection that no one ever catches cold from a draught. Colds are caused by microbes which get into the nostrils, throat, or windpipe, and by growing upon these surfaces make them red, swollen, and painful. The only effect of a draught is to lower the vitality of these surfaces and so enable the microbes to grow more readily than they otherwise would.

A much better mode of ventilation than that described above is to make the stuffy air leave a room through an outlet tube or duct which lies close to the chimney. When an outlet tube is close to a warm chimney, the chimney will heat the air in the tube and will thus make it lighter, causing it to ascend in the tube and so pass out at the top of the roof.

This outlet duct should open from a room at two places—near the floor, and also near the ceiling, because

expired air being heavier than fresh air tends to fall to the floor, especially when both kinds of air are of the same temperature. If, then, there is only one outlet duct near the ceiling, the foul air cannot escape so readily and must, therefore, tend to accumulate along the floor.

That foul air does accumulate in this way can easily be proved by placing a candle on the floor of a crowded room in which there is little or no ventilation. In the course of an hour or so the candle will grow dimmer and dimmer, and finally go out. It will not go out at all, or at least not so quickly, if placed higher up in the room. The following experiment also illustrates this fact:


FIGURE 8.

Fit a cork into the lower end of a tall lamp-chimney so tightly that no air can enter around it. Now remove the cork temporarily and place upon it a short piece of a lighted candle. Insert the cork again and watch what happens. The candle will soon go out,—and for precisely the same reason as it will go out when placed upon the floor of an unventilated room. (Fig. 8).

As the stuffy air escapes from a room, fresh air comes in through walls and chinks wherever it can find entrance. Of course, the quantity of fresh air that will thus enter a room cannot be sufficient for good ventilation, and so in many buildings, especially in school-houses, an inlet tube or duct is used

(Fig. 9). The inlet duct, *A*, takes fresh air from the outside of the building at about five feet above the level of the ground, *D*, and conveys it to the furnace, *C*, in the basement where it is warmed. Thence it passes through other ducts to the schoolroom. The pupils then get an ample supply of warmed fresh air.

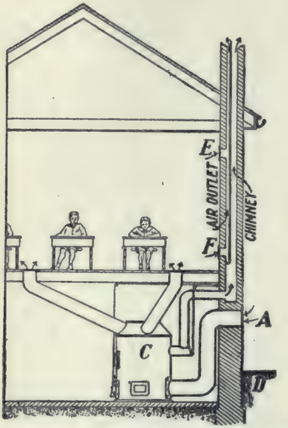


FIGURE 9.—*E* and *F*, openings into the outlet duct beside the chimney.

It is usually better to admit the warmed air by a number of openings, so as to distribute it more evenly throughout the room; and the same thing is true of the outlets. If there is only one opening for each, then perhaps Figure 10 illustrates the best arrangement.

FIGURE 10.—The circulation of warmed air.

A very common plan of ventilating dwelling-houses at the present time is illustrated in Figure 11. Two or three adjoining rooms may be ventilated by separate outlet ducts—one for each room—all joining a common outlet duct which lies near the chimney.

The advantage of ventilating our houses by this system of air-flues is that the ventilation is continuous. It is

spoken of as a "natural" system of ventilation, to distinguish it from an artificial one, in which the air is either drawn into a room or forced out of it by ventilating fans.

Our school regulations specify that there shall be an air space of 250 cubic feet for each pupil in a school, and that this quantity of air shall be changed three times

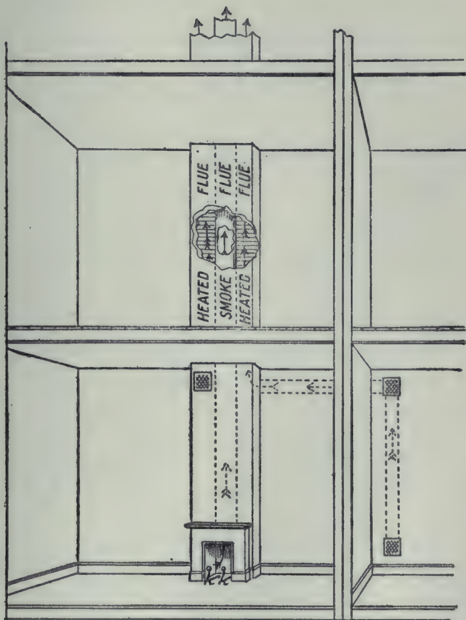


FIGURE 11.—Outlet ducts for ventilating adjoining rooms.

per hour, thus furnishing each child with 750 cubic feet of fresh air an hour. If we assume that 250 cubic feet more of fresh air comes into a school in winter through

the porous walls and through chinks around windows and doors, we see that each child will have about 1,000 cubic feet of fresh air an hour.

This, however, is often not sufficient. In some American states, school trustees are required to provide each child with at least 1,800 cubic feet of fresh air an hour, and this is very desirable in the interests of the health of the children.

In conclusion it should be said that there is no single standard by which we can judge of the ventilation of a room. In general we may say: (1) that the temperature of the air should not exceed 68 degrees F.; (2) the movement should be gentle and without draught; (3) the carbon dioxide should not exceed 6 parts in 10,000; (4) the air should be free from excessive dust, bacteria, and gases; and (5) the requisite moisture should be provided either by placing pans of water upon every radiator or by having a number of healthy plants growing in the room.

CHAPTER VII

THE CHOICE OF A DWELLING

What sort of house should we live in? Should it be large or small? Should it be built of stone, brick, wood, or concrete? Should it be located upon a hill or in a hollow? If in a city should the presence of dust and smoke be carefully considered? Should a low rental be the chief consideration, or should the house be chosen because it is sanitary; that is, because it will help to conserve the health and well-being of the family?

It would be waste of time to discuss with you the requisites of a large modern house—its site, foundation, size, lighting, heating, furniture, and materials of construction. Such houses are only for the few. Rather let us consider what the minimum requirements should be in a house for a labouring man and his family. And first of all, should the house be large or small?

Before you attempt to answer this question, let me ask you to consider some statistics that were collected by the late Dr. J. B. Russell, medical officer of health, Glasgow, Scotland:

Size of Houses	Number of people living in these houses	Percentage of total population	Percentage of total number of deaths	Deaths per year
One room..............	134,728	24.7	27.0	3,636
Two rooms.............	243,691	44.7	47.0	6,325
Three rooms...........	86,956	16.0	13.0	1,747
Four rooms............	32,742	6.1	4.3	581
Five rooms and upward..	38,647	7.1	3.3	434
Public Institutions.......	6,531	1.4	3.2	427
Untraced..............	....	....	2.2	289
Whole city population...	543,295	100	100	13,439

As you may see, about half the inhabitants of Glasgow live in two-room houses. The percentage of deaths in these houses is higher than the percentage of population. In some other cities in Europe the conditions are quite as bad as in Glasgow. In American cities, while the conditions are somewhat better, it is nevertheless true that just in proportion as people crowd together in cities, so there is a corresponding increase in the death-rate.

Note again the much lower death-rate—only 3.3 per cent.—among the inmates of those homes which have

five rooms and upwards. So low is the death-rate here that you are, no doubt, quite prepared to say at once that no family should ever live in a house that contains less than five rooms. As there is an average of about five persons in every family, it follows that the death-rate is lowest in homes in which there is an average of one room for each member of the family.

Perhaps some of you may tell me that it must make a great difference whether the five rooms are small or large. So it must. You can easily imagine a family living in a five-roomed house, in which the rooms are so small that they do not contain as much air as does many a one-roomed or two-roomed house. A house, for example, such as many of the early settlers in America built, had only two rooms—one on the ground floor and one upstairs, and yet in these two-room homes the death-rate was very low. One reason for this is that only the strong and hardy emigrated to the New World. Another reason is that the heating and cooking were done by means of large, open fireplaces, and, consequently, the ventilation was unusually good.

Accordingly, we cannot decide upon the proper size of a house simply by counting its rooms. We must look at their size as well.

If possible we must fix upon the number of cubic feet of air that each member of a family should have, in order that his health may not suffer from lack of fresh air. Suppose we fix upon the air space which has been prescribed by law for schools as a fair standard for adults as well as for children. This standard is different in different localities. In Ontario it is 1,000 cubic feet per

hour for each child, but in many places in the United States it is 2,000 cubic feet. Applying the lower standard to a labouring man's house, we find that if there are five persons in it, the house should contain a space of at least 5,000 cubic feet. This would mean a house about 25 feet long, 20 feet wide, and 10 feet high, whether it contained one room or five. On the higher standard of 2,000 cubic feet per person, the house would require to be double the number of cubic feet given above.

A house of smaller size than 25 feet long, 20 feet wide, and 10 feet high, would do for a family of five, if its ventilation were up to the standard prescribed in the chapter on ventilation, pages 20-26. This standard, however, cannot be maintained in small houses without creating a draught that might be dangerous to the health of the inmates. In fact, one reason why so many houses are badly ventilated is because the inmates object to draughts. It is agreed among physiologists that the volume of air that must enter a house in order to keep the air fresh, without producing at the same time an objectionable draught, is 3,000 cubic feet per hour per person.

Having fixed upon the minimum size—and no family however poor should live in a smaller one—let us consider some of the other requisites of a sanitary house.

The windows should be large in proportion to the size of the house, so that sunshine may flood every room, killing microbes and aiding in the production of good red blood in those inmates who are compelled to live all day in the house. The window frames should be so constructed as to allow the upper portions to be transoms turning on a pivot and thus promoting ventilation. As

a further aid toward adequate ventilation, outlet air-ducts (as already described on pages 24, 25) should lead from each room to a large air-flue in the chimney or adjoining it.

The bedrooms should open upon sleeping porches by means of either French windows or Dutch doors. The former are really glass doors which open down to the level of the floor.

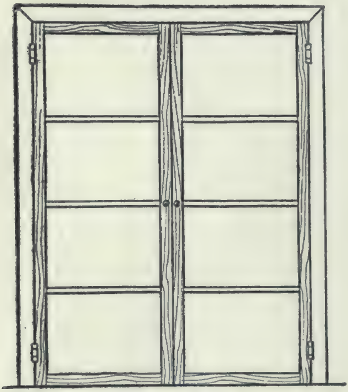


FIGURE 12.—French window. Opens on the level of the floor.

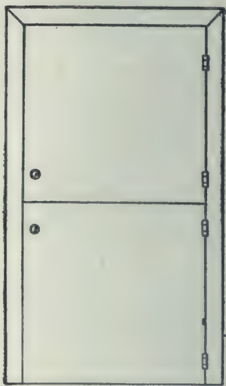


FIGURE 13.—Dutch door.

The Dutch door has an upper half which is exactly like a window, and may be raised by pulleys and weights so as to disappear into the wall above, or may open like a door. The lower half is like an ordinary door, being hinged to open inward or outward.

The purpose of both the French window and the Dutch door is to aid in ventilation and to allow the bed to be rolled out upon the verandah or sleeping porch and to be withdrawn at pleasure.

Every consumptive, and in fact all other members of the family, would be benefited by sleeping on the porches throughout the year. On the approach of winter the beds should be withdrawn from the sleeping porches during the day into a warm bedroom. At bed-time, patient and bed should be rolled out on to the sleeping porch and should remain there all night. Of course, the bed-clothes must be adequate. The head also must be protected by a cap warm enough to prevent the sleeper from catching cold. In the morning the occupant returns to the warm bedroom, where the dressing is done.

The success which has attended the open-air treatment of consumption indicates clearly enough that, if a man would protect his family from this disease, he must seek a house that is provided with either sleeping porches or the most perfect kind of ventilation.

The site of a dwelling should be chosen so as to secure pure air, plenty of sunshine, and perfect drainage.

As regards the foundation, many houses are too low. Generally speaking, the earth which comes out of the cellar should be graded round the house, so as to form a terrace about eighteen inches above the natural level of the ground. The first floor should be at an elevation of about two or three feet above this grading. When this is the case, the basement need not be dug much below the surface level—a most important matter in securing good drainage in a flat district.

The materials out of which houses are usually built are brick, stone, wood, or concrete. It would be useless for us to discuss the comparative advantages and disadvantages of each of these. No one doubts that a perfectly

sanitary house can be built out of any one of them; but whether houses with soft-wood floors, baseboards, wooden doors and window frames can be kept hygienic without a great deal of trouble and labour is open to doubt.

To be sanitary a house should be provided in summer with screens on the doors and windows for the purpose of keeping out house-flies. These insects are to be found everywhere in the northern parts of North America in July, August, and September. As scavengers they visit privy-vaults, decaying flesh, and all kinds of dead waste from animals. If windows and doors are not screened, they are likely to visit the table during meal-time, and in walking over the food may transfer the germs of disease to members of the family.

As food must be kept fresh in order to be wholesome, it follows that every sanitary house should be provided with a cold-air closet in which food can be kept. This closet should be lined with galvanized iron. Through it fresh air can be made to circulate during moderate and cold weather. In hot weather ice must be used in it, and the dirt that always accumulates in an ice-box should be removed by flushing with water.

In cities a house generally has its waste-pipes connected with the kitchen-sink, bathroom, and water-closet. It is of the utmost importance, therefore, that the joints of the drain-pipes and all traps which open into them should be so tight that not the least trace of any bad odour can be found in the house. In fact, the drainage of a house must be carefully considered in every detail; all the more so if the house is located in a flat district, where there can be little or no fall of the ground away from the house.

The furnishings of a house should be such as to throw as little labour as possible upon the housekeeper. When floors are buried under carpets, when windows are hidden with lace curtains, and walls are covered with paper, it is very difficult to keep a house clean, and a dirty house is an insanitary house. Painted walls are even more sanitary than whitewashed ones, because they can be readily washed; and, similarly, painted floors are more sanitary than bare ones.

The greatest care should be taken to furnish a house simply. Hardwood chairs and tables are all that are necessary for the kitchen and living room. Single iron bedsteads should be the rule. Folding beds or sofa-beds are objectionable on hygienic grounds. Generally they are used to save space, and in the morning are closed up too soon to allow of the bed-clothes being properly aired and sunned; but, with sleeping porches in general use as they should be, there would be no necessity for using folding beds.

Some of you are no doubt asking whether the foregoing requirements for a labouring-man's house are not too high. Before deciding this question, read over again the chapter on the effects of bad air, look again at the effects of living in small, sunless, and badly ventilated houses, note the small size and the lack of ventilation in the houses of many working-men, and then say whether in your opinion there are not to-day too many of these houses which entail upon their inmates the certainty of sickness and untimely death.

A house which will not promote the health of every one of its inmates should be pulled down.

CHAPTER VIII

THE BURNING OF THE BODY

What becomes of all the air which enters our bodies? Well, as soon as it reaches the lungs the oxygen part passes through the thin walls of the blood-vessels and enters the blood. As the blood is circling round and round in the body all the time, the oxygen is thus carried by the blood to every part of it.

What becomes of the oxygen then? It leaves the blood through the walls of the exceedingly small blood-vessels and enters the flesh. Then the same thing takes place in the flesh as takes place in a stove or furnace, namely this, some of the flesh is burned up.

When we wish a fire to burn well, we put some wood, like cedar or pine, into the stove and turn on the draught; that is, the damper is opened so as to allow air to pass in freely. When we do this, the fire burns well; when we close the damper and keep the air from getting into the stove, the fire burns slowly. It goes out altogether if we stop the air completely.

Now, in some respects, the body is like a burning candle, or a fire. To be sure there is no flame to be seen in anyone's body; but, as you all know, there is heat.

Can we have burning without flame and without light? Of course we can, and most people have seen this kind of burning. How does a mason make plaster? He gets a load of quicklime from a limekiln. This he puts into a large, flat, open box, and then he pours upon it many pailfuls of cold water. In a few minutes a hissing sound is heard somewhat like the hissing of

steam from the tea-kettle. In fact, the cold water which the mason has poured upon the quicklime soon begins to boil. If you put your hand upon the lumps of quicklime they feel hot. Soon afterwards, they swell up and mix with the water and form a white liquid like milk. But all this time a kind of burning is going on in the quicklime and water, which is somewhat like the burning going on in our bodies. There is never any flame or light, such as may be seen in a candle, or a fire, but there is plenty of heat. We may say indeed that the burning in our bodies is a kind of wet burning; it is burning without any light and without any flame

If we are like stoves, there should be smoke coming off from our bodies, and there should be ashes forming somewhere, just as in a stove. Very true. Two kinds of "smoke" do come off at the top of a chimney, smoke which we can see, and smoke which we cannot see. Now the smoke which comes off from our bodies is smoke which we cannot see. It passes out mixed with expired air. It is like the smoke which passes off from a burning candle—invisible smoke.

A burning candle can no more do without fresh air than we can. How long will a candle burn without fresh air? To get an answer, take a short piece of candle and light it. Now put a glass fruit jar, mouth downwards, over the candle, so as to prevent any air from getting into or out of the jar. Watch what takes place. The flame grows dimmer and dimmer, and then goes out altogether.


FIGURE 14.—Candle burning under a fruit jar.

Repeat this experiment a number of times. John Mayow, the physiologist, did it often many years ago, and always with the same result. Later on in his work in place of using a candle he used a mouse, and found that its breathing made some change in the air inside the jar which caused the animal to die.

We conclude, therefore, that a candle, in burning, produces something in the air that makes it unfit to keep up the burning; and that a mouse, in breathing, produces something in the air which makes it unfit to breathe again. Both candle and mouse require oxygen for their burning, and both give off the invisible smoke, carbon dioxide, which mixes with the air.

But what about the fuel and ashes of our bodies? If our bodies are like stoves, where does the fuel come from? We may call the food which we eat the fuel for our bodies. The food is either turned into blood and flesh, or part of it is stored in the flesh as fuel. Then this flesh or stored food burns by means of the air which enters our bodies, and, in burning, gives rise to heat, to invisible smoke, and to what I may call ashes.

Yes, ashes. To be sure we cannot see these ashes as we can the ashes in the ash-pan of a stove; but ashes are produced nevertheless. They do not remain in the body and clog the burning, as ashes do sometimes in a furnace; but very tiny specks of ashes are forming all the time in the flesh. They are so very small that we could not find them if we looked for them ever so carefully; but they are not so small that the blood cannot find them and gather them all up nearly as fast as they form.

The invisible smoke is carried to the lungs and passed out in the expired air, and the ashes from the burning flesh or stored food are carried, some of them to the skin, some of them to the kidneys, and some to the intestines, and thence they are thrust out of the body. The lungs, skin, kidneys, and intestines are known as "excretory" organs, and the waste materials which they thrust out of the body are called "excretions". If the excretions, or what I have been calling smoke and ashes, were not quickly removed, we could live only a very short time.

Drinking freely of water, between meals, aids very much in the removal of the dead waste or ashes of the body. The water first enters the blood-vessels, so that more blood passes into the flesh, dissolves the waste, and helps to remove it. This is one source of the benefits which have been received by sickly people who have, in all ages, gone to drink the waters of mineral springs in different parts of the world.

The burning which goes on in our bodies does something else besides keeping them warm. It enables us to move about. Just as the burning of wood, or coal, or gasoline enables a traction engine, or a locomotive, or an automobile, to move from place to place, so the burning in our bodies enables us to carry on all our bodily movements. It enables us to walk, run, work, and play. The movements of the chest in breathing, and the beat of the heart in pumping the blood, are alike caused by the burning of our bodies.

It has been calculated that about five-sixths of our food goes to form heat, and about one-sixth goes to produce bodily movements. In some respects we are like a locomotive, but we differ also vastly from one.

We control and direct our own movements; but a locomotive must be run by an engineer. We see, hear, feel, and think; but an engine is only a mass of dead metal. While it is helpful, therefore, for us to think of ourselves as engines, we must remember that this is true only of the mechanical side of our existence.

CHAPTER IX

REGULATION OF THE BODY HEAT

How do we regulate the heat in a school-room?

If the room becomes too warm, the windows are opened so as to allow the heated air to escape. In addition to this, the damper of the stove or furnace is closed so as to shut off the draught; thus, less air reaches the wood or coal, and less heat is produced; so that between the opening of the windows and the decrease in the burning, the room soon cools down and becomes more comfortable.

On the other hand, what is done when the room is too cold? In this case the windows, if open, are closed. This prevents the escape of some of the heat; but, besides this, the damper of the stove or furnace is opened, so that more air reaches the wood or coal and causes the fire to burn up more brightly. Thus more heat is produced and the room grows warmer.

The temperature of the body tends to rise and fall in much the same way as does that of a room. When a person suffers from fever, his temperature often rises as high as 104° or 105° F.; when he has been exposed to

prolonged cold, as he is when he passes the night in a drunken sleep without shelter, his temperature may fall to 95° F. or even lower. These, however, are unusual variations. In a state of health, so nicely are the gain and the loss of body-heat regulated that the temperature in the mouth is almost exactly 98.4° F., all the year round. Now, this cannot be the case unless there is some mechanism by which our bodies make more heat or less heat, as stoves do; and some other mechanism by which they keep in the heat or lose the heat, as rooms do. It would be a very bad thing for us if our bodies did not possess some power of regulating their heat.

And so they do. Our bodies are burning all the time and giving out heat, but not always at the same rate. At some times they make much more heat than at others. In fact, when we are in good health, they keep changing the amount of heat according to the weather. On a cold day or in a cold room our bodies make more heat. On a warm day or in a warm room they make less heat.

How is this done? By our bodies acting in much the same way as a stove is made to act. When our bodies tend to become cold, messages go along nerves from the skin to the spinal cord without our being conscious of them. As a result of this, other messages go from the spinal cord out to the muscles of the chest, and we breathe faster or deeper; that is, we take in more air, just as a stove does when the damper is opened. The burning, therefore, goes on more quickly in our bodies, and more heat is produced.

While the breathing becomes quickened, the blood-vessels lying in and under the skin grow smaller;

so that less blood goes to the surface, and, therefore, less heat is lost. In fact, our bodies regulate the heat in nearly the same way as a wise teacher regulates the heat in a school. Only there is this difference: the making of more or less heat in the body and the loss of more or less heat from the skin are both regulated by the nerves of the body without our being conscious of the changes.

The watery part of sweat plays a very important part in regulating the heat of the body; because, as the sweat comes out on the skin it evaporates; that is, it dries up and passes into the air. Now in order to change liquid sweat to vapour of water, heat is required, and this heat is withdrawn from the body. Consequently, our bodies are greatly cooled by the evaporation of perspiration.

As there is very little evaporation of sweat from the skin of dogs, the loss of heat from their bodies takes place chiefly by evaporation of moisture from the mouth, throat, windpipe, and bronchial tubes. The faster dogs breathe the more quickly evaporation goes on, and the more they are cooled. This accounts for their rapid breathing in hot weather; they are cooling themselves.

CHAPTER X

ALCOHOL AND BODY HEAT

Before discussing this subject it will be well to inquire what is meant by alcohol. Of course you have all heard of whisky, brandy, beer, ale, and wine, and have probably seen these liquors. They differ from one another in colour and taste, but resemble one another in having a

disagreeable taste; at least they are all at first disagreeable.

They all contain a certain substance which chemists call ethyl alcohol; but the quantity of this substance which is present in whisky, brandy, wine, and beer is different for each liquor. You may get a rough idea of the quantity of alcohol in each of these liquors if you look at the following figures:

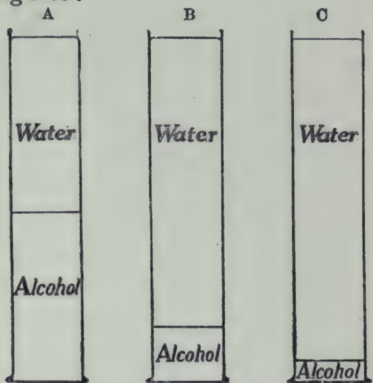


FIGURE 15.—The relative proportions of alcohol and water in (A) brandy or whisky, (B) wine, and (C) beer.

Ethyl alcohol is a liquid resembling water in appearance. It is extensively used in different trades and manufactures. For example, the druggist uses it in the manufacture of medicines. The roots, leaves, or stems of certain plants are cut into very small pieces, alcohol is then poured upon them, and in the course of several hours or days the alcohol dissolves out from these portions of the plant certain substances which are used as medicines and are known as alcoholic "extracts".

Then again alcohol burns well, giving out no smell and no smoke, and it is therefore used as a fuel in "spirit" lamps, and in motor engines. It has been used extensively for preserving many small animals in jars. The alcohol withdraws most of the water from the dead animal, and it also hardens the flesh, the result being

that putrefaction does not take place. This is the way in which many animals have been preserved in school and college museums.

Druggists use alcohol in making perfumes; painters use it in making varnishes; chemists use it in making smokeless powder; and manufacturers use it in making "lead-pencils", though there is no lead in them. In fact, alcohol is a most useful substance, and dozens and dozens of articles whose manufacture require alcohol would be much cheaper if alcohol were not used as a beverage.

While we can see from these examples how very useful alcohol is in the trades and manufactures of a country, we must be on our guard against thinking that ale, wine, whisky, and brandy are equally useful in the everyday lives of men, women, or children. On the contrary, these liquors should never be taken excepting under the advice of a skilled and experienced physician.

If you understand how the body regulates its heat, you will have no trouble in understanding how alcohol affects the heat of the body in winter.

As everyone knows, some people drink whisky or brandy in cold weather because they think it makes them warm. Now what the whisky really does is this: acting through the nerves, it widens the bore of the blood-vessels of the skin and allows more blood to pass to the surface, as may be seen at any time in the flushed face of one who habitually uses it. If the weather is cold, this blood becomes much cooled, because it is so near the surface; and, when it returns to the windpipe, lungs, and intestines, it cools them below their natural

temperature. The consequence is that the vitality of these organs, or what we may call their resistance to disease is much reduced, so that disease germs may start to grow in them and cause diseases like bronchitis, pneumonia, or diarrhœa. Thus the whisky actually upsets the healthy working of the heat apparatus of our bodies. In place of helping to keep the body warm it really makes it cold.

Those who travel in arctic regions nowadays never drink alcohol in order to keep warm. Dr. Carpenter tells about a crew of sixty-six men who left Denmark and wintered in Hudson Bay. They took an abundant supply of alcohol with them, thinking that it would help them to keep warm. By the end of the winter they were all dead but two men, because the alcohol had destroyed the power of their bodies to regulate their temperature.

As an example of how the very opposite practice turned out, an English crew of twenty-two men wintered just as far north as the Danish crew, but they used no alcohol. In the spring twenty of them were alive and well. The heat apparatus of their bodies had been left uninjured by alcohol, and this had helped them to pass the cold winter there without any harm.

We may keep the heat apparatus of our bodies in good working order by taking good care of our general health and by taking a cool bath every morning if we are strong enough to stand one. The bath stimulates the nerves which control the heat apparatus, so that this apparatus is always ready to generate more heat or less heat when required. Besides this the bath alters the

blood supply to the skin, so that it gives off heat or retains heat just as may be needed.

Nor does alcohol make us cool in hot weather, as some drinkers would have us believe; in fact, it slows down the circulation of the blood, because it decreases the force of the heart-beat. The heat will thus tend to accumulate in the body, and in very hot weather this would help to produce heatstroke. The effects of alcohol, therefore, are bad, whether we drink it in winter or in summer.

CHAPTER XI

HAIR

Two kinds of hair are found growing on the human body. The first is the hair of the head and face. The second is the fine short hair which can be found growing on the arms, chest, and other parts of the body. It is easily seen on the back of the hand. It is shorter, thinner, and finer than ordinary hair or whiskers, and grows very slowly during our lifetime. In some people it is so fine and short as to be almost imperceptible, while in others it is so long and thick as to resemble that which grows on the bodies of some animals.

A single hair, whether of the head or of the body, grows out from the bottom of a little "follicle" or tube which dips down into the skin and which can be seen only with the aid of a microscope. Each hair gets its food from little blood tubes or vessels; has a

nerve thread running up to the root; has a small muscle joined to its side; and lastly, each has a little bag-like gland which sends out a kind of oil along the side of the hair. So we see that the two kinds of hair are very much alike.

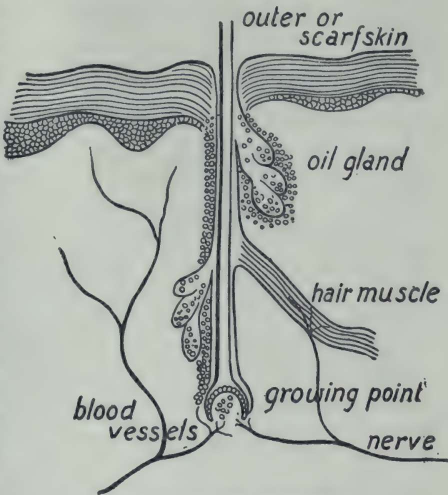


FIGURE 16.—A hair in its follicle.

Perhaps the strangest thing about hair is that each one should have a little muscle joined to the side of the root. What is the use of this muscle? We know that wherever we find a muscle in any animal, it has only one use. It makes the parts of the animal move. But who ever saw a man's hair moving? The old poet Virgil tells us that the hair on Aeneas's head stood on end the night the city of Troy was captured by the Greeks; and we often hear of similar cases—the hair on a person's head standing up through fear or on account of some very strange sight; but these cases are in reality very rare, and only a few persons have ever seen them.

Hairs are joined to the skin only at the very bottom of the hair tube, at a point known as the *growing point.* The growing point has a rich supply of blood, and it is

from the blood that the material comes out of which hair is made. When the growing point dies the whole follicle dies, and all the "hair restorers", "hair tonics", or "hair oils" in the world cannot make the hair grow again.

When a hair is pulled out from the scalp of a young person in good health, another will grow in its place if the growing point is not killed. Hair that falls out, as it sometimes does, merely from want of proper care or after a serious illness, will grow again of its own accord if the scalp is properly cared for.

FIGURE 17.—Touching hair on the back of the hand with a lead-pencil shows that a hair is an organ of touch.

Hair begins to turn gray first upon the temples. In most people, gray hairs show themselves at about forty years of age. Some people, however, turn gray about twenty-five, and others not until fifty-five or sixty. The cause of gray hairs is the failure of the growing point to form the colouring matter which gives colour to the hair. At forty-five or fifty the hair begins to fall out, and thenceforward it is never so thick as in early life. The change in colour and thickness marks a gradual loss of bodily strength, not merely in the skin but in the whole body. When a man is sixty years of age, white, thin hair tells him as plainly as words can that his bodily powers have begun to fail.

The colour of a man's hair, its coarseness or fineness, the fact of its falling out early in life or turning gray at thirty or thirty-five years of age, are all generally

explained by saying that he inherits these peculiarities from parents or near relatives. But whether a man is descended from a gray-haired or a bald-headed family or not, he should take great care of his hair.

No hair tonic can be applied and no rules can be followed which will prevent hair from turning gray; but by washing the hair weekly or fortnightly, and by massaging and brushing the scalp for a few minutes two or three times a day, the hair can be prevented from falling out for years. What is meant by massage will be explained more fully later on.

Tight, heavy hats or caps impede the circulation of the blood in the scalp and tend to make the hair fall out. Pulling upon the hair when combing out tangles, or putting it in curl papers, also tends to make it fall out, by injuring the growing point or by causing its death.

CHAPTER XII

THE SKIN

Most young people know that the outer layer of the skin, that is the scarf skin, does not hurt when it is pricked with a pin or cut with a sharp knife; and they know also that, when a blister forms, a drop or two of a watery liquid collects between this outer skin and the true skin beneath. After this watery liquid dries up, the outer coat may be peeled off without causing any pain.

But there is one thing about this outer coat which many people do not know. Like hair and nails, it is

growing toward the surface all the time. Why then does it not become thicker and thicker like the bark of

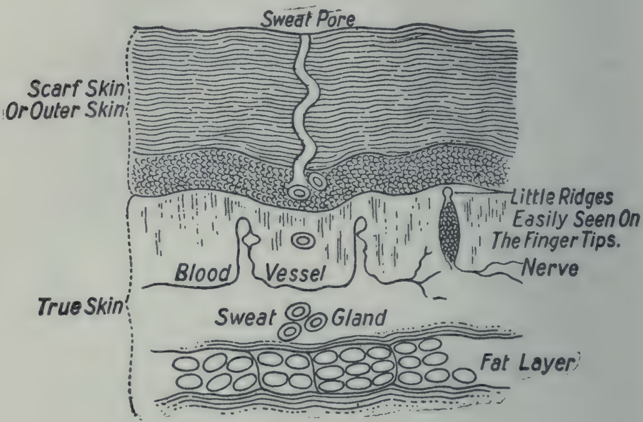


FIGURE 18.—Vertical section of the skin.

some trees? The answer to this question is that the skin is slowly peeling off at the surface every day we live.

In most people the rate of growth is about the same as the rate of peeling, and, therefore, the thickness remains about the same. This is also true of the bark of some trees, such as the arbutus. But with people who never take a bath, the skin thickens and becomes covered with a crust of dirt as well. This does serious harm to the health, although the harm does not come upon such people all at once. If a person is very strong, it may take years before he suffers very much from allowing his skin to grow thick and dirty. Slowly and surely, however, he will have to pay for his folly.

We shed our skin little by little, in bits so small that we scarcely notice them. Flakes of skin, so small as to need a magnifying glass to see them, stick to our underclothing, or come off when we wash our face and hands or take a bath. This skin is dead and useless, and should be removed in order to keep the body strong and healthy.

Why must it be removed? No doubt there are people who have never bathed and who nevertheless seem to be in good health. A disagreeable odour generally comes from the sweat and clothing of such people. This bad odour arises from the decaying scarf skin as well as from the sweat.

As everyone knows, sweat, or perspiration, comes away from the skin when we are too warm. It comes away also when we are not warm at all. You may prove this for yourselves by placing your hand up to the wrist in a large wide-mouthed bottle. The bottle must be dry and cool. In a half minute or less a little mist forms on the inside of the bottle. This is the invisible sweat which is coming from the blood-vessels through the skin, or from the small pores or openings in the skin.

FIGURE 19.—The hand in a bottle showing moisture forming from the sweat-pores.

If we should cut open one of these pores and examine its inner end with a magnifying glass, we should find the small rounded body which made the sweat. It is called a sweat-gland. There are probably between one

and two millions of these glands in the human skin. The quantity of sweat given off from them daily is very variable. It is very difficult to measure the quantity exactly, because it varies from time to time with the kind of food, the quantity of fluid drunk, the temperature of the air, the season of the year, and the work done by other organs, such as the lungs and the kidneys.

About one-third of an ounce of the daily output of sweat is salt and other substances, the rest being, of course, water. With the watery part of sweat we are not at present concerned; but, as we have already seen, its chief use is to keep us cool when we are too warm. When this watery part dries up, it leaves behind it on the surface of the skin the salt and other substances of which we have just spoken. Water, on the other hand, which has been spilt upon the floor dries up, we know, and disappears; that is, pure water leaves no trace behind it.

Where does this solid matter in sweat come from? In answer, it may be said that the sweat-glands obtain it from the blood, and the blood obtains it from the flesh, bone, nerves, and other parts of the body. Part of these waste products which the blood gathers from all over the body is carried to the sweat-glands to be thrown off through the pores. If the dead skin is not removed from the body by bathing or rubbing, the sweat-pores become clogged, and these waste products may be retained in the body. This places greater work on the kidneys and other organs, and finally, if they fail to do this extra work, ill-health results.

From what you know about the sweat-glands and the skin, you will see that you must practise cleanly habits if you wish these organs to get rid of the dead and poisonous materials that are always forming in the body.

Strong people should bathe in cool water (about 80° F.) every morning. So should delicate children and aged people if they can stand the cold, but if they cannot they should use tepid water (about 90° F.). The best soap should always be used in taking a bath. Bad soap injures the skin.

If there is no bathroom in a house, the whole body should be sponged or rubbed over with a towel or linen mitten dipped in cool water. This should be followed by brisk rubbing with a coarse towel.

Once a week before going to bed a warm bath (about 100° F.) should be taken. This removes portions of the scarf skin which are not readily removed by cold water even with the aid of soap. Moreover, for evident reasons, all underclothing should be changed at least once a week and invariably taken off at night and hung up to air.

The nails should be cut regularly with a pair of scissors, and shaped round like the end of the finger. No cleanly person ever allows dirt to accumulate beneath his nails, and no cleanly person ever bites off the tips of his nails. The habit of biting the nails, if kept up for some years by a child, results in the ends of the fingers becoming blunt, rounded, and ugly.

CHAPTER XIII

THE NOSE AND THE THROAT

The nose is of great use to us in other ways than in enabling us to smell. It warms, moistens, and filters the inspired air. For example, when we are travelling in dusty cars, the nose stops much dust from passing down the throat and into the lungs. The dust gathers in a ring

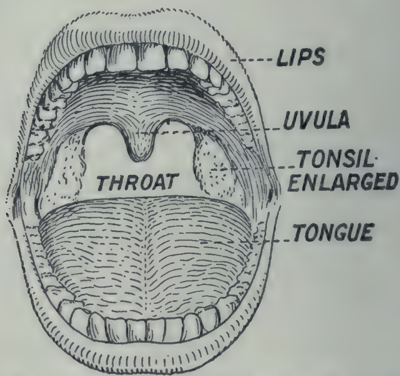


Figure 20.—The mouth and throat as seen by the aid of a looking-glass. The tonsils are represented as being swollen and diseased. When not diseased they are level with the inside of the cheek and not easily recognized.

at the entrance to the nostrils. The same thing may be noticed in men who have been working close to a threshing-machine or who have been shovelling coal.

The nose stops also many of the invisible germs of disease from passing down the throat. In fact, the nose may be more useful to us in this silent work of keeping out dust and disease germs than it is as the organ of smell.

When you open your mouth and by means of a mirror look toward the back of it, you see your throat. But there is another passage into the throat besides the one from the mouth. The two nostrils join each other about

FIGURE 21.—Front to back section through the nose, mouth, throat, windpipe, and gullet. 1, the uvula; 2, the epiglottis which covers the opening into the windpipe; 3, a cavity in the bone; 4, a cavity in the forehead bone; 5, the back part of the mouth; 6, the upper part of the throat, into which the nose passages open.

one and a half inches from the tip of the nose, and open by one passage into the throat behind. The large chambers just inside of each nostril are for use in

smelling; the passages backward into the throat are for breathing.

Lying under the skin (called the mucous membrane) of the nose, mouth, and throat, are a large number of small organs somewhat like sweat-glands. In these glands juices are forming all the time. When in a healthy condition, the juices help to kill the disease germs which may happen to enter the nose along with the dust. The dust and germs are caught upon the mucous membrane of the nose, throat, and windpipe, and, when their accumulation becomes disagreeable, we cough and discharge them from the mouth as sputum.

It is very important that there should be a free and open passage for the air from the front opening of the nose right back to the throat. Sometimes in children the paired nostrils, just where they join and enter the throat, become closed up by growths of soft flesh, called "adenoids", so that the child cannot breathe through its nose. Its breathing must accordingly be done through the mouth. Now this mouth-breathing, as it is called, is very bad for the child, because the dust and invisible germs in the air cannot be stopped so well as in the nose passages. If, therefore, we breathe through the mouth, there is danger of catching certain kinds of disease.

FIGURE 22.—Face of a mouth-breather.

Besides this, mouth-breathing causes the teeth to stick out and spoils the shape of the mouth. If you find, therefore, that you breathe through your mouth instead

of through your nose, you should lose no time in consulting your doctor.

There is a disease of the tonsils (Figure 20) which has come to be looked upon in recent years as very important. It is known as tonsilitis. The tonsils become enlarged, painful, and an abscess frequently forms. In these circumstances the doctor has to remove them, or at any rate the diseased portion. If the disease recurs, as it sometimes does on account of colds or irritation of any kind, it is best to have the whole tonsil removed. Otherwise germs and poisons may remain, may become absorbed into the blood, and produce other diseases elsewhere in the body.

The best advice that can be given about caring for the nose and the throat is to avoid catching cold. "Bad colds" and "la grippe", or "influenza", are caused by bacteria. These bacteria do not usually grow in a healthy nose or throat, but they do start to grow very readily in the throats of people who possess no resistance to disease germs, and in the throats of those who have been chilled by cold moist winds. If one is out in such weather for a long time, the cold drives the blood away from the throat and inner surface of the nose, and unless one is hardy, a "cold" is the result.

When we catch cold the mucous membrane of the nose or throat becomes red, swollen, hot, and more or less painful. That it is red and swollen may be seen at a glance by simply opening the mouth as wide as possible, facing a window, and then examining the throat by means of a looking-glass. No one need be told that his throat is painful; he knows that already. When we

have a cold, the small glands which lie within the nostrils do not work properly, and they send out a large quantity of unhealthy discharge. Besides all this, there is a feeling of considerable discomfort throughout the body.

Colds in the head are bad enough in themselves for the reason just mentioned; but they become serious for other reasons. When the lining of the nose and throat is irritated and swollen from a long continued cold, and children so troubled happen to go into a house where there is measles, scarlet fever, diphtheria, or small-pox, the germs may start to grow upon the red and swollen surface or they may pass through the skin and get into the blood and set up the disease.

Some people are more liable to catch cold than others. Either they are naturally weak and delicate, or they have made themselves "soft" by wearing too much clothing. People who remain much in over-heated houses in winter or who always wash the face and throat in warm or lukewarm water, are also very liable to catch cold.

CHAPTER XIV

THE TEETH

The teeth of all creatures are of various shapes and sizes according to the work which Nature intended them to perform. For example, the dog has a number of teeth in the front of the mouth which have thin, sharp edges, and which are used to bite off portions of food. These teeth are called incisors. Back of these, he has long tusk-like teeth, called canines, with which he

tears his food. Further back still, he has large teeth with cusps or points, which he uses in breaking up the hard portions of his food so that they can be swallowed.

In man the teeth are somewhat different. He has the same chisel-edged teeth in front, which he uses to bite off portions of his food. He has canines at the corners of his mouth, but they are not long and tusk-like as in the dog. Farther back the teeth have broad, rounded surfaces, indicating that they are designed for grinding his food into very small particles.

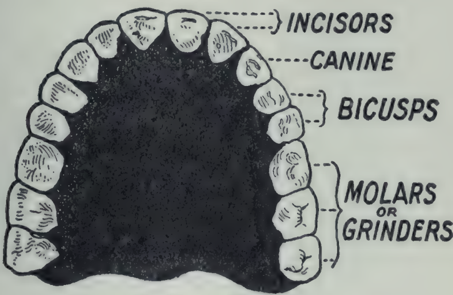


FIGURE 23.—Teeth in the upper jaw.

The first teeth to make their appearance in a baby are the four central incisors. These are followed at intervals by other teeth, until at two years of age twenty teeth are in place—ten in each jaw. Between the ages of six and twelve these teeth are gradually replaced by others, but it should be borne in mind that these first twenty teeth are most important and should remain in the mouth until replaced by nature.

As the child grows, three additional molars appear upon each side, at the back of the mouth. These molars

do not replace the first teeth, but come out back of them. The first usually appears at about six years of age, the second at twelve years, and the third at about eighteen years or later. These three molars on each side, above and below, make an additional twelve teeth, so that the complete set numbers thirty-two—sixteen in the upper jaw and sixteen in the lower.

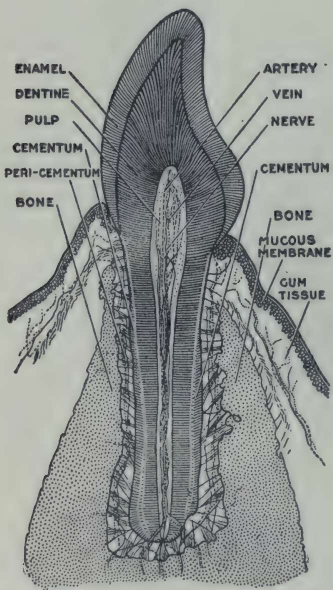


FIGURE 24.—Section of a tooth showing enamel, dentine, cement, and pulp cavity.

The accompanying Figure shows all the principal parts of a tooth The part not covered by the gums is the crown, and the part covered by the gums is the root. The crown is covered with a hard, white, shining substance called enamel, and the root is covered with a less hard substance called cementum. These two substances cover the main portions of the tooth called dentine. In the central dentine of the tooth is a small hollow which contains the pulp and consists principally of flesh, blood-vessels, and nerves. The tooth is held in the jaw by a thin fibrous membrane which attaches the root to the jaw-bone.

One important fact must be noted here. Some people are blessed in having been born strong. Just because they come into the world strong, healthy babies, they grow into strong, healthy boys and girls, and their teeth are strong, hard, white, and shining—teeth which bacteria can scarcely harm at all. On the other hand, there are babies who are born with weak bodies, and especially with weak bones. When they grow up to be boys and girls, they have teeth that are soft—that crack easily and decay soon, and require a great deal of care to keep them from being lost. Many strong people, too, have sound teeth up to sixty or seventy years of age, while others lose all their teeth before they are thirty. Generally, the one class of people get their good teeth from healthy parents; the other class get their bad teeth from delicate parents.

FIGURE 25.—Teeth that have become bad through a bad heredity.

But, while all this is quite true, it is also true that whether we are blessed with strong, healthy teeth, or suffer from bad and decayed ones, we should wash them and brush them and try to preserve them as long as we can.

Two diseases affect the health of human teeth. One is decay or caries, which destroys the tooth substance; the other is periclasia (formerly called pyorrhea) which destroys the attachment of the teeth to the jaw, causing the tooth to become loose and finally to fall out.

Decay is due chiefly to lack of cleanliness of the teeth. When too much sugar or too much starchy food is eaten,

FIGURE 26.—A case of pyorrhea or periclasia viewed under high powers of the microscope. *P.C.*, pus cell. *S.*, the organism which causes the disease. *F.b.*, fusiform bacteria. *E.C.*, a cell from the lining of the mouth.

the teeth become coated with a sticky, pasty material, the bacteria which are always present in the mouth change it to acid, and this acid dissolves the teeth and causes caries. The use of the tooth-brush to keep the surfaces of the teeth clean will prevent some of this decay. A very much better way is to follow nature's method and eat foods that require plenty of masticating. People should eat very slowly, and they should take a certain quantity of hard food, such as nuts, toast, biscuit, and crusts of bread, in order to polish their teeth and keep the gums healthy.

When cavities do form in the teeth, they should receive treatment at once. As the conditions that cause caries are not easily recognized, it is wise to have the teeth examined regularly by a dentist every few months. If neglected and decay continues, the cavities become larger

and larger until they reach the pulp. Teeth in which the pulp is dead have been observed to cause rheumatism, heart disease, skin disease, eye disease, sore throat, and swollen neck. Toxines or poisonous matter is probably carried in the blood from the decaying teeth to these other organs, causing disease in them. It is wise, therefore, to have cavities treated when they are very small.

Dental periclasia means a breaking down of the tissues surrounding the teeth. It appears in several forms, as for instance, receding of the gums, or swelling of the gums at the neck of the teeth. It is also indicated in the discharge of pus along the edge of the gums, and in loosening of the teeth.

Dental periclasia results from two causes, one local and the other general. The local cause may be the deposit of a lime salt under the free margin of the gum, assisted by bacteria.

The general, or as it is sometimes called, the constitutional cause, must be due either to the inheritance of a poor quality of teeth, or to lack of resisting power on the part of the blood to the growth of bacteria.

The surest way to prevent this disease is to keep the teeth and the space under the free margin of the gum scrupulously clean. If allowed to proceed, dental periclasia may result in the loss of teeth by loosening, and it may also give rise to the diseases mentioned above in connection with teeth having dead pulps.

Some parents, knowing that their children lose all their first teeth between six and twelve years of

age, do not think it worth while to have the first teeth cared for. But these teeth should be kept clean, and the cavities in them should be treated just the same as in the case of the teeth which replace them. When the first ones are well cared for, the child does not have toothache, it can chew its food better, the food nourishes the body better, and the child grows larger and stronger, and the teeth which replace them are better.

FIGURE 27.—Protruding teeth.

When the first teeth are taken out too soon or are left in too long, the ones following come in wrong position and spoil the beauty of the mouth. This defect the dentist remedies by using gentle pressure and keeping it applied to the teeth for months. In this way the uneven teeth are pressed into the proper position.

FIGURE 28.—The same after adjustment by a dentist.

The great matter in caring for the teeth is to keep them perfectly clean. The tougher portions of food which become fixed between the teeth should be removed with a quill, and the soft particles should be brushed off with a tooth-brush. The brushing should be done upward on the lower teeth and downward on the upper teeth, never across the teeth.

The best time for brushing the teeth is at night and in the morning.

CHAPTER XV

KINDS OF FOOD

At the beginning of Chapter VIII we compared the human body to a stove, and later in the same chapter to a locomotive or an automobile. Just as a locomotive burns coal to produce its heat and motion, so the body burns one portion of its food in order to produce heat and movement. But there is one important particular in which we are quite unlike a locomotive or an automobile. When these machines are damaged or partly worn out, they are sent to a machine shop to be repaired. Not so with our bodies. Although minute portions of our bones, muscles, nerves, and blood are wearing out every minute we live, no physician—no matter how learned or skilful—can make the necessary repairs to them. The body makes its own repairs out of another portion of food, if it is of the proper quantity and quality. In short, food is used for two different purposes by the body.

1. One portion is used as fuel to furnish the heat of the body and also the muscular movements, as in breathing, the circulation of the blood, walking, playing, and working.

2. Another portion is used as repair material in making good the waste that is going on all the time in the blood, muscles, nerves, and other tissues of the body. The same kind of food that repairs waste in adults and young is also used for growth in children. Any of this kind of food that is not needed for repair or for growth is burned for fuel, but it costs more money than the special fuel foods do, and should, therefore, be used sparingly. (See page 71).

Let us now try to get a clear idea of these two kinds of food, and, in order to do so, we shall study the composition of cow's milk. What does milk consist of? Chemists who have analysed it tell us that the milk from a healthy cow contains the six following substances:

				PARTS
I	Protein or curdy matter or repair food		about	3½
II	Fat, that is, the cream or butter.	These two are fuel foods.	"	3½
III	The carbohydrate, milk sugar		"	5
IV	Mineral salts, like table salt, and other salts		"	¾
V	Water		"	87
VI	Accessory factors of food, in small amounts.			
			Total	100

These are the substances found in milk, and these substances or others very like them must be taken into the body as food. Moreover, the proportions in which they occur in milk are just about the proper proportions in which we should take them in all our other foods.

I. Proteins are found in all kinds of lean meat, whether it be in beef, mutton, pork, fish, or fowl. They are found also in many vegetables, and whether of animal or vegetable origin are absolutely essential for the repair of tissues in both old and young, and for the growth of the young. Without meat or meat substitutes, including milk, our meals would not nourish the body properly.

II. Fats are found in milk as cream, in fat meats, in olives as olive oil, and in nuts. Lard and suet are other fats. They are fuel foods, and, when burned in the body, furnish, as has already been said, both heat and muscular movement.

III. Carbohydrates include both starchy foods and sugars. The sugars are found in small quantities in fresh

fruits. Cane sugar is extracted from the sugar-cane and from beet-roots. Malt sugar may be extracted from malt; lactose from milk; and glucose and fructose from fruits. The starchy foods are found in bread, oatmeal, potatoes, etc. The sugars and the starches, when burned in the tissues, furnish most of the heat and muscular movement of the body.

IV. The mineral substances are often spoken of as salts. In addition to table salt, or common salt, which we take with many of our foods, vegetables and fruits furnish other salts which are essential to health. The lime salts, for example, found in milk, are essential for the growth of the bones of children. So also salts of iron, found in lean meat, milk, and eggs are necessary in forming blood.

V. Then our food should contain a certain amount of indigestible material, sometimes called "roughage". Such material is found in the framework, or what might be called the skeleton of the vegetables which we eat. Just because it is indigestible, it stimulates the movements of the intestines and prevents constipation. Meats contain little of this roughage, and, consequently, an exclusively meat diet tends to produce constipation, besides some other bad effects.

VI. Foodstuffs contain some other substances besides proteins, fats, carbohydrates, salts, and roughage, that are essential to growth and health. To illustrate what is meant, let me remind you that in Asia many people live for months upon a diet of polished rice, that is, rice with the husks off. The use of such food, when continued for a long time, brings on a disease known as beri-beri. The

polished rice is deficient in some substances that are necessary for health and even for life itself. Any diet that lacks such substances is said to lack "vitamines", or one of the "accessory factors" of foods.

The vitamines are present in various kinds of foodstuffs in minute quantities, but are absolutely necessary to maintain an adult in good health. Vitamines appear to be necessary also for promoting the growth of young animals.

Polished rice when fed to pigeons brings on the symptoms of beri-beri—muscular and nervous symptoms followed by death. Before the effects have become fatal, the animals may be restored to health by feeding them on the unpolished rice. The husks of the rice, therefore, must contain some elements of food that are removed from the polished rice. Similarly, human beings that have acquired beri-beri through the long-continued use of polished rice may be restored to health by eating the unpolished rice.

British history will remind you of a time when British sailors were fed exclusively upon salt pork and hard biscuit. Such sailors sooner or later took scurvy and died. The disease was attributed to the excessive use of the salt meat. To-day we know that scurvy is not due to this cause, but to a deficiency of organic substances such as are found in all fresh fruits and vegetables. Citric acid from lemons and oranges, tartaric acid from grapes, and mellic acid from apples, etc., are indispensable substances in food, because they furnish the accessory foodstuffs which help to maintain the blood and other tissues in a healthy condition.

The proof that vitamines are necessary for the growth of young animals was furnished by Hopkins in 1912. He showed that young animals fed upon pure protein, pure fat, and pure carbohydrate, including the necessary amounts of salt and water, will not thrive. They will live on this diet, but will not grow. If, however, a minute quantity of fresh milk be added, growth goes on rapidly.

Infantile scurvy appears to furnish evidence to the same effect. This disease sometimes breaks out in even a well-managed infants' home, if the infants are fed exclusively upon sterilized milk, condensed milk, or prepared or patent foods.

It will be seen from the foregoing that most of our foodstuffs belong to more than one class. For example, wheat from which white bread is made contains about 12 parts of protein, about 1½ parts of fat, about 70 parts of starch, about 14½ parts of water, and 2 parts of salt, besides roughage.

Similarly, beef contains about 17 parts of protein, an average of about 26 parts of fat, a mere trace of starch or sugar, about 4 parts of salt, and about 53 parts of water.

On the other hand, potatoes contain only about 2 parts of protein, about 75 parts of water, about 20 parts of starch, about 3 parts of salt, a mere trace of fat—$\frac{1}{10}$th of 1 part, and, of course, roughage.

If you will compare the composition of these foodstuffs with that of milk, you cannot fail to see how far they fall short of being the perfect food that milk is, at least for children.

It is very hard to tell exactly how much of each of the three chief foods—proteins, fats, and carbohydrates—is necessary for health. The amount varies in different persons, and it varies also in the same person from time to time.

CHAPTER XVI

DIET

The fact that our foodstuffs differ so widely from each other in the amount of protein, fat, and carbohydrate which they contain makes it necessary for us to select for our meals portions of bread, meat, potatoes, sugar, and fruit. No selection is necessary in feeding infants, because all the different kinds of food are ready mixed in milk; but adults have to choose for themselves the proper quantities of each foodstuff which they must eat, in order to get the repair material and fuel materials which the body requires.

Fat alone, or starch alone, or its first cousin, sugar alone, will not support life. Nor will these three together support life. Protein is absolutely necessary. It does not require much protein to support life, but some protein we must have. We may get the protein from milk, from eggs, from meat, or we may get it from vegetables like peas or beans, which contain a great deal of vegetable protein—a good deal more than bread does—but, we must get a certain amount of it from some source. And, in the same way, we must get a certain amount of fat; not too much, and not too little, but just enough for the needs of the body. So, too, in

the case of starch or sugar, a certain amount of this is necessary for making healthy blood.

Scientists have studied the food of a great many people who were free to choose their own diet, and find that the following table represents roughly the quantities of each kind of food that is eaten every twenty-four hours by an ordinary man of sedentary habits. Women eat somewhat less. The selection is not based upon the sense of taste in children, or in those who have no self-control. If it were, the selection would very likely include an excess of sugars, preserved fruits, and probably pastry, and to that extent would not represent the diet of sane people at all:

Proteins or curdy matter.........	2 to 3½ oz., or 100 to 120 grams	28.35 grams equal 1 oz.
Fats..............................	3 oz., or 100 grams	
Carbohydrates (sugar and starch)	9 to 12 oz., or 250 to 300 grams	
Water, tea, or coffee, up to about	85 fluid oz.	

Salt, in addition to what is in the food, is usually taken in quantity to suit the taste.

The quantities of the above foods must be greatly increased if men are doing heavy manual labour. Soldiers and sailors on active service require much more food than those doing moderate labour. The following is generally considered to be a suitable diet for men at heavy labour in the open air:

Protein..........	158 grams	28.35 grams equal 1 oz.
Fats.............	200 "	
Carbohydrates....	500 "	

In a warm climate the fuel foods—the fats and carbohydrates—may be somewhat decreased. In cold climates the proteins and particularly the fats must be greatly increased. Nansen, the famous Arctic explorer,

tells us that he and his men used to get up in the middle of the night to eat fats or drink oil. They had a strong craving for this kind of food. It was needed by the body in order to make heat. The great cold of the north made them eat large quantities of fat, which they would have loathed when in their southern homes.

The minimum quantity of protein which is required to keep the body in good health has been the subject of many experiments and of much discussion. Men who are free to choose their own diet instinctively eat about 3½ ozs. or 100 grams of protein per day. But this quantity is used only by people who are fairly well-to-do. Investigation has shown beyond all doubt that many people who have comparatively small incomes do not take more than 75 grams per day. Moreover, there are well-authenticated cases of men who have lived for several months and done light work upon a diet that contained only about 30 grams of protein. Whether a man could live for a number of years upon so small a quantity of protein and remain in good health is open to very grave doubt.

There does not appear, however, to be any doubt that a man can do a moderate amount of work and live upon a diet made up as follows:

Proteins	75 grams	28.35 grams equal 1 oz.
Fats	50 "	
Carbohydrates ..	400 to 500 grams	

Comparing this diet with the two given on page 69, it is clear that people who wish to economize can do so in two ways: first, by reducing the protein income of the body from 100 grams to 75; and secondly, by reducing the fat income from 100 grams to 50. If the protein

used is lean meat, there is a saving in the butcher's bill of twenty-five per cent., and a saving of fifty per cent. in the grocer's bill for butter or lard.

But this is not all. If, in place of lean meat, we use peas, or beans, or lentils for the necessary protein, we effect a further saving in the cost of living, because beans, peas, and lentils are all cheaper, weight for weight, than lean meat. And the same thing is true in the case of fat. If the fat which we use is butter, a great saving can be effected by using oleomargarine instead.

I do not pretend to say that everyone will enjoy eating beans or peas as keenly as they would meat. Quite the contrary, because the meat extracts which are obtained in cooking appeal to the appetite much more strongly than do the extracts of vegetable proteins. But I do say that when we desire to practise economy in diet, without danger of suffering from malnutrition, it can be achieved by reducing the animal fats and proteins, and substituting, in part at least, the cheaper vegetable proteins and oils.

In accordance with these suggestions, the following quantities of food will be found sufficient for a family of five for one day. The family is supposed to consist of a father, mother, and three children ranging from 5 to 10 years of age. When a proper selection for the three meals is made, the diet will furnish all the proteins, fats, carbohydrates, mineral salts, roughage, and vitamines, which are required to maintain the family in good health.

4½ lb. of bread. The equivalent of this bread would be 3 lb. of flour, oatmeal, hominy, corn-meal, or rice.

Another equivalent would be 2¾ lb. cereals and 5 or 6 potatoes of medium size.

¾ cup of fat. The fat might be in the form of butter, beef drippings, or other fat. The weekly allowance may be placed at from 2½ to 3 lb. Oil and lard are substitutes.

1 cup of sugar, or a weekly allowance of 4 lb. The sugar might be replaced with honey or syrup.

4 lb., made up partly of fresh fruits and partly of fresh vegetables, or root vegetables.

3 quarts of milk. The milk is absolutely essential for child growth.

1 lb. of meat.

CHAPTER XVII

DIGESTION

Digestion starts in the mouth. "But how can it start in the mouth", you ask, "when the food remains there such a very short time?" Quite true it does remain a very short time in the mouths of people who eat quickly; but it remains a comparatively long time in the mouths of people who care for their digestion. These latter keep the food in the mouth until it has been chewed almost into a liquid. By doing so, the saliva and the food become so thoroughly mixed that, when the liquid reaches the stomach, the saliva continues for about forty minutes to change the insoluble starches of the food into a soluble form.

If our food always remained in the solid form in which it is eaten, the blood could get very little nourishment out of it. As a matter of fact, all digestion, whether in the mouth, the stomach, or the intestines, means the change of solid food into soluble food. Only through such a change as this can the food pass into the intestinal walls and be carried onward in the blood to nourish all parts of the body.

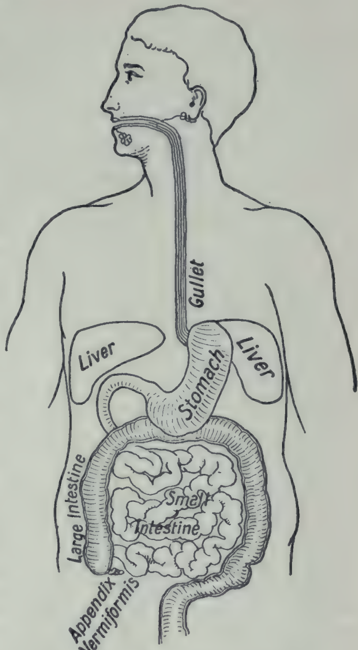


FIGURE 29.—The alimentary tract.

While the mere passage of the food along the intestine is sufficient of itself to promote digestion, it is well known that food which possesses an agreeable odour and taste causes the brain to send special messages to the digestive glands, and that these messages greatly favour the outpouring of the juices and their action upon the food. But let care, worry, anxiety, sorrow, or any other strong emotion press upon a person, especially upon a delicate person, and at once there start other nerve messages from the brain, which hinder digestion or stop it altogether. Hence the rule that no cares or

worries should ever be brought to the table during meal-time.

When the stomach and intestines are digesting the food properly, we do not know that we possess these organs; but, when we suffer pain after eating and the stomach feels sore or tender on being touched, we may be quite sure that we have indigestion. It is unwise to neglect the plain hints which Nature thus gives us in the form of discomfort, pain, weakness, and the heavy beat of the heart, known as "palpitation".

The weakness is easily understood. If the stomach and bowels do not digest properly, the blood cannot get enough nourishment out of the food, and so cannot give sufficient nourishment to the nerves and muscles. The consequence is that we feel sick and weak and cannot do our work.

There are many causes of indigestion which it would be useless to discuss in detail with you; but they may all be roughly summed up by saying that indigestion is due (1) to eating the wrong kinds of food, (2) to eating improperly cooked food, (3) to eating food in the wrong way, that is too fast, (4) to eating too much food, (5) to working fast or working hard soon after eating, or (6) to the fact that a person has been born with weak digestive organs.

How many of these causes can you control? You say, of course, that when you become men and women with homes of your own you can control all of them except the last, and you are possibly right. A boy who has come into the world with a weak stomach and intestines is badly handicapped in the race of life. Fortunately,

there are not many such children. Those who are thus afflicted must always have the special care of mothers, nurses, and doctors.

But except with the few who have delicate digestive organs, indigestion is a disease which may be avoided altogether if people will only follow the rules of hygiene in eating, and also in regard to exercise and fresh air, which aid both the appetite and digestion. It is not treating the stomach right to take medicines and drugs advertised to aid digestion. Beer, wine, whisky, and other alcoholic drinks are sometimes called aids to digestion, but their continued use weakens the stomach and causes indigestion. Chronic inflammation of the stomach is met with in heavy drinkers, especially in those who indulge in large quantities of spirits. These strong drinks cause irritation of the stomach lining; but the weaker ones also sometimes disorder digestion by delaying the process. "Some people think they cannot digest without wine," said a French doctor in a discussion of this subject, "but this is a self delusion. I have treated numerous dyspeptics who improved as soon as the wine was stopped."

Sometimes indigestion shows itself in the form of either constipation or diarrhœa. While the food and liquids are passing through the intestine—in all a distance of 25 or 30 feet,—it often happens that much of the liquid is withdrawn from the bowel into the blood. When this takes place, the undigested portions of the food may become hardened and then their passage out of the body becomes difficult. This is what is meant by "constipation". On the other hand, little or no liquid may be removed from the bowel during digestion; in

fact, more liquid may be added to what is already in the intestine, and then the discharges are very watery. This condition is known as "diarrhœa".

Now both these conditions are often due to errors in diet, and they can both, generally speaking, be cured by choosing a proper diet and persevering in its use. In the case of diarrhœa, you may have to follow a prescribed diet for only a few days; in the case of constipation, you may have to persevere in its use for weeks or even months. In all obstinate cases of either disease you should consult a physician.

Constipation is the source of a great deal of misery and suffering in the form of headache, tiredness, and giddiness. No doubt some of its ill effects are due to the fact that the natural drainage of waste from the intestines becomes blocked up. To prevent it, plenty of fruits, vegetables, vegetable soups, and salads should be eaten, but these must not be too highly seasoned. A glass of cold water the first thing in the morning often helps, and so does deep breathing. Then, too, a person must take plenty of exercise in the form of work or of games, and should, as far as possible, relieve the bowels at the same hour every day. This last rule is very important.

A word or two may be said here in regard to the act of eating. There should be regular hours for meals. Some children eat too fast and eat too much, and often as a consequence make themselves sick. Very little liquid should be drunk with meals, unless care is taken to chew the food as long and thoroughly as if no liquid were taken.

Another rule is not to play or do any kind of work immediately after eating. There should be a rest of half-an-hour after each meal, to allow digestion to go on unhindered.

Next in importance to selecting plain, wholesome, fresh foods, is the duty of seeing that they are well cooked. As regards this, girls must rely upon instructions which they can get from their mothers, and from useful books upon these subjects.

CHAPTER XVIII

THE INFLUENCE OF FOOD

Of all the influences to which a growing child is naturally subjected, probably the dominating one is food. This statement is strikingly illustrated by some statistics which were collected and published by the Commissioner of Education in Washington, D.C., in 1889. The facts are almost exactly like some other facts which have been published regarding pupils in some European schools. Remember that these statements are based upon the average of a large number of measurements of boys and girls. There must, therefore, be children who are exceptions to the general rules here laid down; for example, some big-headed boys learn slowly, while some small-headed boys are very bright and quick in their studies. But apart from such exceptions, the general statements hold good. These are as follows:

1. As the circumference of the head increases, ability increases.

2. The children of intelligent people have a larger circumference of head than the children of the ignorant.

3. Bright boys are taller and heavier than dull boys.

4. Children of intelligent people have greater height, weight, and length of body than children of the ignorant.

5. Children of intelligent people show greater ability in their studies than children of the ignorant.

These facts seem to mean that the children who are best fed, best clothed, and best housed, will, as a rule, have the best chance to get on in the world; whereas, poorly fed, ill clad, and poorly housed children can hardly ever hope to be more than hewers of wood and drawers of water for others. Poorly fed children are those who get too little milk, too few eggs, and too little butter and meat, because these kinds of food cost much more money than vegetable foods do.

While it is important that children should be well fed in order to become strong men and women, it should be also said that there is a prior condition necessary in children if they are to grow into big, sturdy adults. They must be born of strong fathers and mothers. As a rule, strong parents have strong children and sickly parents have delicate children. Sometimes, however, it happens that a puny child is born to sturdy parents and a fairly strong child to weakling parents.

But if we assume first of all that babies are strong and healthy when they are born, then the question of whether they will grow into robust men and women will depend more upon good food than upon any other one thing. The same statement may be made regarding

plants. Fruit trees, vegetables, and grains rapidly increase in strength and size when they are well fed, but they remain weak and small when ill fed. Upon many a sandy hill or gravelly knoll the grass is scanty and short because it is ill fed, whereas on rich, moist flats it is long and thick. Animals, too, grow strong and fat when they get plenty of nourishing food. This statement is easily verified by observing the young cattle upon any first-class farm.

This is a general law in the growth of all living things: herbs, trees, grasses, fowl, cattle, sheep, horses, and human beings, all vary in vigour and health—that is, they are large and strong, or thin and sickly—according as they get plenty of food or too little.

If you wish to realize how a plentiful supply of good food promotes the growth of young animals, look at

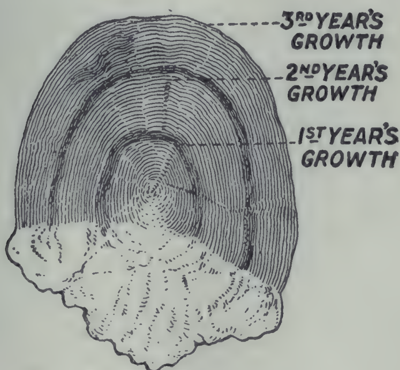


FIGURE 30.—Scale from a salmon.

Figure 30, representing the fine surface markings on the scale of a salmon two and a half years old.

You will observe that there are in all five groups of semi-circular concentric rings, and that the rings of the first, third, and fifth groups are more numerous and comparatively wide apart; while those of the second and fourth groups are fewer in number and lie closer together. The rings of the first, third, and fifth groups represent the increased growth of the fish during three summers when food was plentiful; whereas the second and fourth groups represent the lessened growth during the winter when food was scarce.

Similarly, we find rings of growth on a cow's horns, just where the horn grows out from the head; and there are corresponding rings on the hoofs, each representing a year's growth and the accompanying winter check.

No doubt, too, you have often counted the rings on the trunk of a tree. Each ring represents a summer's growth, due to the fact that food is plentiful. Some rings are wider than others, evidently because in some summers the food supply is more abundant than in others.

Knowing these facts we may well believe that the growth and development of boys and girls, in both mind and body, are to some extent dependent upon the quantity and quality of the food which is supplied to them by their parents.

CHAPTER XIX

THE STORING OF FOOD

After a potato is planted it either decays entirely, or else becomes smaller and smaller and gradually dwindles to a blackish, shrunken ball, very unlike what it was at first. In the same way, the big root of the parsnip or beet shrivels up during the second year of its growth and becomes much smaller than it was at the end of the first season.

FIGURE 31.—Parsnip root during the first season of growth.

Now, the substances which make up the mass of the potato and of the parsnip root must have come from their food. These plants derive part of their food from the soil in the form of water and earthy salts dissolved in the water, and they get the rest from the air, chiefly the gas, carbon dioxide, which we and other animals pass out from the lungs. These materials are digested in the green leaves when the sun is shining and are changed into sap, and from this the material is derived which we find stored in the root, stems, leaves, or seeds of some plants.

Starch is one of the most important substances which green plants manufacture. This they store away for their own use or for that of their offspring. Most of

our foods—bread, porridge, potatoes, vegetables, and fruits—come more or less directly from plants. From plants we get the starches, sugars, oils, and salts upon which millions of human beings live. Of course, plants do not store for the use of the human race; man has simply taken possession of what plants have stored for themselves or for their offspring.

FIGURE 32.—Parsnip root toward the end of the second season of growth. Compare with Figure 31.

If you examine a grain of wheat or barley, you see that it is made up of two parts, a tiny baby-plant which is packed away in one corner of the seed, and surrounding the baby-plant a greater or less amount of stored food in the form of protein and starch. The parent plant has stored up these foods for the young plant until such time as it has grown its own roots and leaves and can obtain food for itself from the soil and the air.

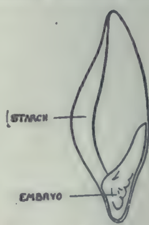


FIGURE 33.—Barley grain, showing the starch and the embryo or young plant.

Many animals store food for their young in very much the same way as plants do. A hen's egg consists of a very tiny baby-chick lying between the white and the yolk of the egg. And the mass of white and yolk is in reality a store of food for the young chick until it is ready to leave the egg.

Often animals store food for themselves. Squirrels, beavers, and bees lay up a store in the shape of nuts or bark or honey, for winter use. And, in the same way, some plants, such as the beet, parsnip, and potato, store up food in the root or the stem for next season's growth; that is, for the production of seed.

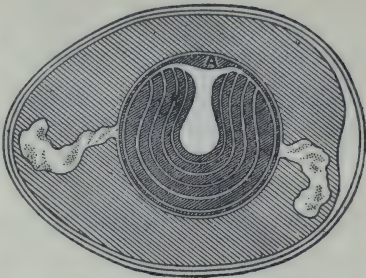


FIGURE 84.—Parts of a hen's egg. The dark part on top of the yolk at *A* represents the tiny chick.

Do we, too, store starch and oil? Yes. Lying immediately under the skin of all well-fed people and well-fed animals you find a layer of fat, and fat also is stored around the kidneys. Another substance, animal starch, is stored in the liver and in the muscles.

Now this storing of fat and starch in the human body is a very vital matter. The animal starch, or "glycogen", as it is generally called, is stored for but a short time, generally from one meal to the next. More or less of it is turned into sugar and carried by the blood to the muscles, nerves, and other parts of the body, where it burns and gives rise to the heat of the body and to muscular movements.

But in the case of fat, the storing is much more permanent. People do not suddenly grow very thin or grow very fat. What variations there are go on so slowly that well-fed healthy adults do not change much in weight for months at a time, or even years. But let a

prolonged illness come on, and it will soon be seen that the fat underneath the skin gradually becomes used up in feeding the rest of the body; slowly but surely people become reduced almost to skin and bone.

When a person takes consumption it is a matter of great importance whether he has much or little fat stored away in his body; because, as the disease makes progress, the patient always loses weight; in fact, loss of weight and a persistent cough are at first usually, but not always, the only symptoms of this disease. If, therefore, the patient is stout, that is, has some surplus fat to draw upon while fighting the disease, he has just so much the better chance of recovery.

In treating this disease, one of the first things that a physician does is to feed his patient with the most nourishing and easily digested diet which can be procured, in order to improve his general health and increase his power of resisting the disease. In fighting consumption one of the first signs of improvement is increase of the patient's weight.

CHAPTER XX

INJURIOUS DRINKS

When man uses for food the materials which plants and animals have stored for themselves or for their offspring, he is doing what is quite right; because, of course, he cannot live upon sunlight, air, and soil, as plants do. He must have other materials for food. But when he uses these stored materials for the purpose of

manufacturing different kinds of drinks containing alcohol, there does not appear to be any doubt that he is misusing Nature's gifts.

It is stated that no less than 65,000,000 bushels of barley is produced annually in Great Britain to make alcoholic liquors of various kinds, and 32,000,000 bushels imported from other countries for the same purpose.

In Canada in the year ending March 31st, 1917, that is before the manufacture of liquor was prohibited, 206,534,986 pounds of foodstuffs were used in the manufacture of alcoholic liquors of various kinds.

These liquors contain only a small fraction of the nourishment that is in the grain, as this is largely destroyed by fermentation. It can be readily seen, therefore, how wasteful it is to turn good grain into alcoholic liquors.

It makes practically no difference in the amount of alcohol circulating in the blood of the drinker whether he takes an ounce in the form of whisky or the same amount in the form of beer, which he does by drinking as much more beer as makes up the amount. After the alcohol passes out of the stomach into the blood, the proportion which will circulate in the blood for several hours and come into contact with the brain and other organs will be the same whether the alcohol is taken as beer, wine, or whisky.

The important facts to remember about alcoholic drinks are that, as a general rule, people begin by drinking the weaker liquors, ales, beer, and wine. At first the weaker liquors satisfy the desire for alcohol; but as

time goes on, the desire grows stronger and stronger. As in the case of the opium user, who craves larger and larger doses as his system becomes used to the poison, so the user of beer and wine is in danger of gradually increasing the amount he drinks, in order to get more alcohol. Then the drinker of ale and wine may become the drinker of whisky and brandy, and before he knows it, he is in the grip of the alcohol habit.

CHAPTER XXI

THE WORK OF THE BLOOD

No one needs to be told what blood looks like. If a cut in the flesh is large and deep, the blood comes

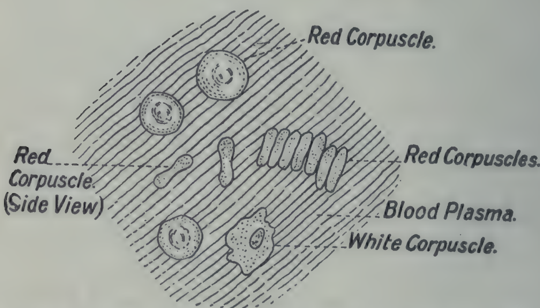


FIGURE 35.—At the top are represented two red blood cells, viewed flat. Below these are nine red blood cells seen edgewise. At the bottom right-hand side, one white cell of irregular outline with a darker central body inside which is known as the nucleus. The white "matter" which comes out of an abcess is made up of pus cells or white blood cells that have died.

out here and there in jets from a set of tubes, called "arteries". At the same time and from the same cut the

blood may well up from another set of tubes called "veins", as water does from a spring.

Very soon after the cut has been made, some of the blood forms a jelly-like mass called a "clot", which adheres to the surface of the wound. The use of the clot is to stop bleeding. Loss of blood is so very serious that Nature has been careful to make the blood of all animals clot very soon after it leaves the blood-vessels.

Freshly shed blood is composed of a pale straw-coloured liquid called "plasma", and, floating in this, a large number of very minute rounded bodies known as blood "corpuscles", or blood "cells". Of these corpuscles there are two kinds—red ones and white ones. The white corpuscles and the plasma are the great carriers of nutritive material. The red take oxygen from the air of the lungs and carry it away in the arteries. On reaching the very smallest blood-vessels the red corpuscles deliver the oxygen to the flesh. Here the wet burning occurs about which you have already read.

The arteries carry the blood all over the body, branching and re-branching the farther away they get from the heart, and becoming smaller in diameter all the time, until finally they become the fine set of tubes known as "capillaries". These convey the blood through every organ and tissue of the body.

The veins gather up the blood from the capillaries and return it to the heart again.

The arterial blood of the body is bright-red in colour, whereas the venous blood is dark-red, the change from bright-red to dark-red taking place while the blood is passing through the capillaries of the body. The change

is due to the fact that the blood while in the tissues loses much of its oxygen and takes on a load of carbon dioxide. You will remember that this gas forms as a result of the burning of the body. The reverse change in colour takes place in the capillaries of the lungs. Here the venous blood changes from dark-red to bright-red through losing its carbon dioxide and taking in a fresh supply of oxygen.

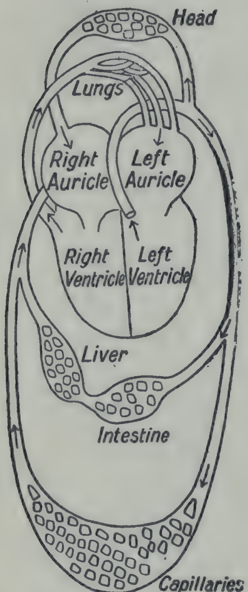


FIGURE. 36.—Diagram to illustrate the pulmonary circulation, that is, the circulation through the lungs; also the systemic circulation, or that through the rest of the body. The arrows show the course which the blood takes. RA, right auricle; RV, right ventricle; LA, left auricle; LV, left ventricle. The tricuspid and the mitral valves are indicated in this figure, but not the semi-lunar valves.

Blood has two great duties to perform. In the first place it absorbs from the walls of the stomach and intestines and carries to all parts of the body most of the nourishing material of the food after it has been digested; in the second place, it gathers up from every part of the body the worn out portions of muscles, nerves, and other kinds of flesh, and carries these to the skin, lungs, kidneys, and intestines. When the blood reaches these four organs, bearing its load of waste matter, these organs remove the waste from the blood; that is, they purify the blood: the waste matter is then thrust out of the body.

Keeping in mind, therefore, the two great kinds of work which are done by the blood, it becomes a matter of vast importance to us to know what kind of food to eat, and how to eat it in order to make good blood; and it becomes equally important to know how to take care of the lungs, skin, kidneys, and intestines, so that they may be able to keep the blood pure. The healthier and more active these organs are, the more efficiently they do their work.

You have already learned how the sweat-glands take dead waste from the blood and thrust it out through the pores of the skin, and how the lungs exhale other waste matter in the form of carbon dioxide and vapour of water. The kidneys, too, are particularly important organs in purifying the blood. In fact, the purest blood in the body is that which has just passed through these organs. By means of the kidneys, waste is excreted from the blood which is not thrown off at all by the other three organs, or, at least, is thrown off in exceedingly small quantities. If the kidneys should stop their work of purifying blood, we could live but a short time.

CHAPTER XXII

CIRCULATION OF THE BLOOD

The blood is made to circulate through the body chiefly by the action of the heart. This organ is about the size of one's fist, and is composed chiefly of muscle. It contains four chambers, or cavities, the two upper ones being known as auricles and the two lower ones as ventricles.

You have all felt your hearts beat. What is meant by a heart beat? Just this; the heart contracts, that is, grows smaller, and presses upon the blood which fills its four chambers. As a result the blood is forced out of the two auricles into the two ventricles, and then from

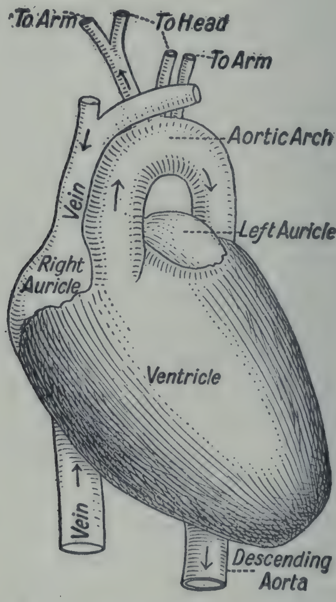


FIGURE 37.—The human heart and chief vessels as viewed from the front.

the two ventricles into the arteries, and is conveyed away by these tubes and their branches all over the body.

While the contraction of the heart is the main force in causing the circulation of the blood, the heart is assisted

in its work by the act of breathing and by the contraction of the muscles all over the body. Vigorous exercise, therefore, whether in the form of play or work, accelerates the circulation; whereas sitting still or lying down hinders it.

The rate at which the blood flows is not the same in arteries, capillaries, and veins. In a large artery like the carotid in a man's neck, which carries blood from the heart to the head, the rate of flow varies from ten to eighteen inches per second; while in the jugular vein which carries the blood back from the head, the rate is only about half as fast. In the capillaries the flow is exceedingly slow. This allows time for the nutritive materials to pass out through the very thin walls of the capillaries into the flesh, as well as for some of the waste material to pass from the flesh back into the capillaries.

The quantity of blood passing through the different organs of the body is varying all the time. After a meal, that is, during the digestion of food, more blood goes to the stomach, intestines, and liver, than when no digestion is going on. For a similar reason, during manual labour or during great muscular exertion such as running, more blood goes to the muscles than when they are at rest. In hot weather, more blood goes to the capillaries of the skin, and, in cold weather, less blood. Generally speaking, the quantity of blood which goes to any organ varies with the amount of work which the organ has to do.

And here comes in a rule of health which everyone should obey: we should never undertake any severe muscular exertion or hard study immediately after a

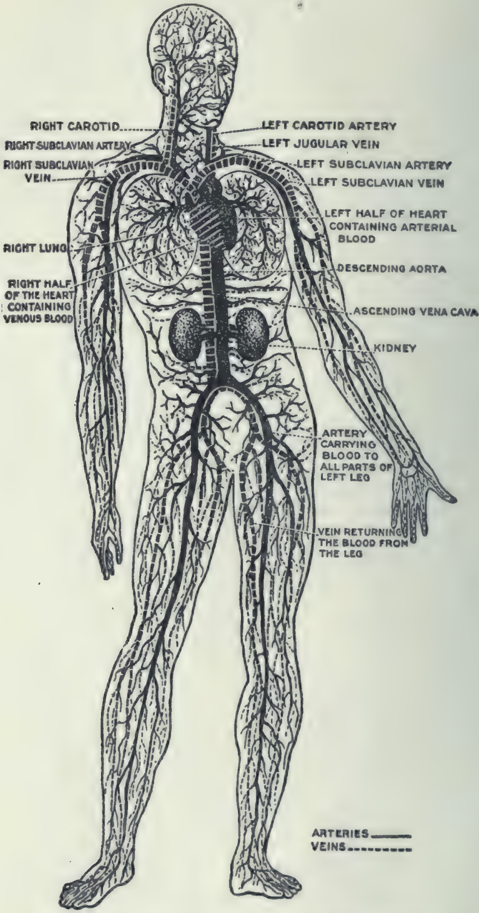


FIGURE 38.—Diagram of the circulation of the blood.

meal. A little thought will make clear the reason for this rule. During digestion, as we have seen above, the stomach, liver, and intestines all require an increased blood supply, and they should get the increased supply by drawing it from other parts of the body. But, if we run or labour violently or study hard after eating, the working muscles or the brain, as the case may be, make a demand for more blood, and, as a consequence, neither the muscles, nor the brain, nor the digestive organs can get the increased blood supply which they require.

There are two artificial ways of quickening the blood-stream; one is by giving medicines called "stimulants", which whip up the heart muscle and make it work harder or faster; the other way is by "massage". Heart stimulants, like digitalis, or strychnine, should never be given except under the direction of a physician, because though they first whip up the heart, an opposite effect comes on soon afterwards, and the heart-beat becomes weaker than it was before. It is well to remember that alcohol is not a stimulant. It is a depressant.

But stimulating the circulation by massage is a very different thing. Massage consists in kneading, pinching, rubbing, and slapping the skin and flesh all over the body in such a way as to bring the blood to the surface and promote its flow toward the heart; that is to say, the kneading and rubbing and stroking should be so directed as to aid the return to the heart of the blood from the arms, legs, and trunk.

The blood-flow being thus increased throughout the whole body, not merely are the healing processes promoted, but there is a more rapid removal of waste.

Moreover, the heart is rested to some extent, because there is now no need for it to beat so fast, and, consequently, we find that immediately after massage the heart-beats fall some ten or a dozen per minute.

CHAPTER XXIII

EXERCISE AND SLEEP

The bones of the body when joined together in their natural positions form what is known as the skeleton.

Suppose you were thinking of the skeleton as lying down, and were devising some plan to enable it to remain standing upright if it were once placed upon its feet. How would it do to arrange straps in pairs all the way up the length of the back and front of the body? The front straps would prevent the skeleton from falling backward, and the back straps would prevent it from falling forward. Additional straps would have to be attached up the side of each leg and also up each side of the trunk, to prevent it from falling sideways. Actually, in a way similar to this, the muscles are attached to the bones and act upon them so as to make the skeleton retain an upright position. Besides, they overlie

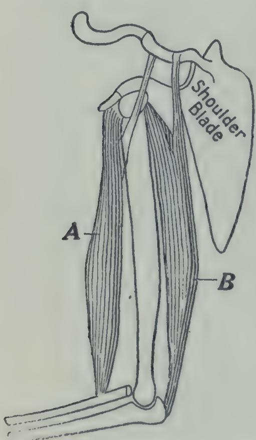


FIGURE 39.—*A* and *B* are antagonistic muscles of the forearm. *A* bends the arm at the elbow. *B* straightens it again.

the skeleton and, along with the fat, give roundness to the form. But muscles do something more than this: they make the body move. In producing bodily movement, muscles usually act in pairs or in sets. For example, when the set of muscles along the front of the forearm contracts or shortens, the fingers are drawn down so as to touch the palm of the hand. When an opposite set on the back of the forearm contracts, the set on the front relaxes or lengthens, and the fingers again become straight. Similarly, the bending of the forearm toward the upper arm is caused by the biceps muscle, a mass of lean meat which you can feel at the front of the arm between the shoulder and the elbow. When this mass shortens and thickens, it pulls upon a bone immediately below the elbow, and the forearm is thus drawn upward to the upper arm. The arm is straightened again by the contraction of a muscle on the opposite side of the upper arm. Whenever, therefore, movement of the body takes place, one muscle or set of muscles shortens, and an opposite (antagonistic) muscle or set of muscles lengthens. If this were not the case no movement of the body would be possible.

A muscle which contracts when we *will* that it should contract, is known as a "voluntary muscle". Most of the muscles of the arms, legs, and trunk are of this kind. In the innermost parts of the body however, as in the intestines, there are other muscles which contract without our being conscious of their movements. These are known as "involuntary muscles".

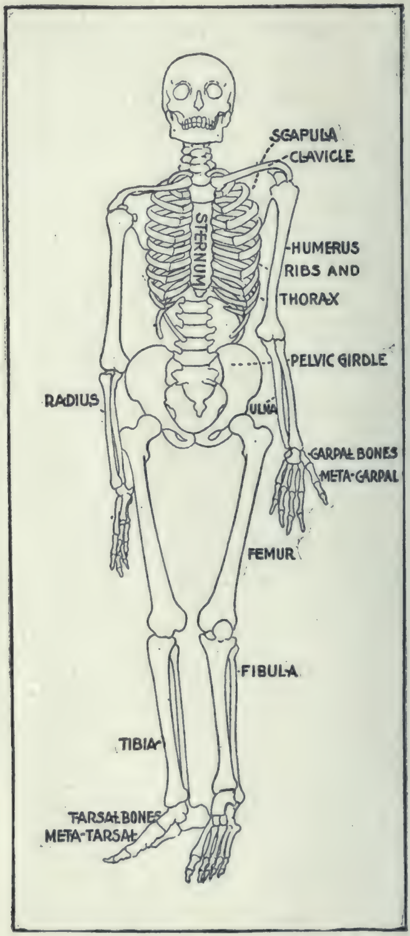


FIGURE 40.—The bones of the body.

When the muscles of the trunk are not properly trained, there is a faulty carriage or a slouchy walk. Either (1) the head hangs forward, or (2) the shoulders are round or "stooped", or (3) one shoulder is higher than the other, or (4) the whole backbone or spine is curved to one side, or (5) the backbone has too slight a curvature at the loins. Of course there are other forms of curvature of the spine which are not due to muscular weakness and which cannot be cured by muscular training.

FIGURE 41.—Right position at a school desk.

Certain occupations, as, for example, sewing, gardening, and lifting heavy weights, are liable to make people round-shouldered; but this tendency may be corrected by exercising the muscles of the back so as to keep the body straight. Unsuitable school furniture also, especially when children are writing or drawing, tends to produce bodily deformities of different kinds.

Young people who have any of these defects should ask their teacher how they may be remedied; and, if the teacher cannot suggest the proper muscular training, the pupil should go to a doctor for advice.

Round shoulders cause compression of the top of the lungs, with a tendency to lung disease. Again, an inerect carriage allows the intestines to settle down into

the pelvis, with a likelihood sooner or later of disease of the internal organs. Both defects can easily be remedied by careful attention to muscular exercise.

FIGURE 42.—Wrong position at a school desk.

An erect carriage is not merely healthful, but it also helps us to maintain our self-respect and to command the respect of others. On the other hand, a lounging gait often excites ridicule or mild contempt.

The use or disuse of an organ produces a very great influence on the organ itself. When properly used, the organ grows in size and vigour, whereas, when improperly used, or not used at all, it tends to lose the power it should naturally possess.

The descendants of fish which have lived for ages in a dark cave have, in the course of many generations, become blind, because their eyes have had no exercise. In the same way, muscles that have had no exercise for a considerable length of time slowly lose their size and strength. In fact, all power of moving a limb is sometimes lost, as is the case when a joint has been kept unused for a long time. Indeed, exercise of our muscles is more necessary for the general health than exercise of the eye or of the ear, useful as these latter may be.

To realize this it is only necessary to learn that there is always present in the skeletal muscles about

one-quarter of the blood of the body. This large blood supply shows what important organs the muscles are. Now, when muscles contract, either voluntarily or involuntarily, the blood-vessels are pressed by the intervening muscles, and the blood is forced onward in its circulation. In other words, muscular contraction is an important aid to the circulation of the blood. On the other hand, sitting still, that is, taking no exercise, will tend to allow the blood to stagnate, and as you will remember from the chapter on the circulation, stagnation of blood will lead to impaired excretion of waste, to lack of proper nutrition, and to lack of vigorous growth.

FIGURE 43.—Boy with stooping or round-shoulders.

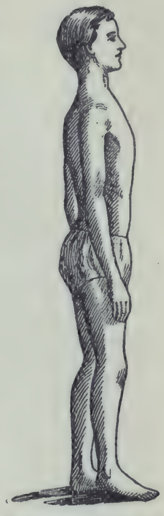


FIGURE 44.—Boy with erect carriage.

And this brings up the question of how much exercise young people should take and what kind of exercise. In answer it must be said that the kind of exercise and its amount depend upon a number of things. For example, they depend upon whether one is well-formed and strong, or ill-shaped and delicate.

For those who are round-shouldered, a special set of exercises should be planned by a teacher or a doctor and

carried on for a long time. Those who have an awkward gait should practise special exercises, so that, in time heavy, lumbering movements may be thrown off or perhaps changed to graceful ones. But such special exercises are for the few only.

Most young people will get the greatest benefit from a combination of exercises, such as are furnished by gymnastics or calisthenics on the one hand, and by games on the other. Each kind has its own special advantage. A properly graded course in gymnastics or calisthenics develops all the muscles of the body symmetrically; games do not. As you will no doubt remember, the skeletal muscles nearly all act in sets or in pairs; hence all those exercises which call into play the muscles of the arms, legs, and trunk, at regular intervals and in regular order, must tend to an all-round development of every muscle of the body.

Games, on the contrary, usually call into play special sets of muscles, and, of course, develop these more than the rest. For example, in playing baseball it is the muscles of the right hand, right arm, and right half of the trunk that are chiefly used, particularly in right-handed persons. The same thing is true of hockey and lacrosse. Hence these games and others like them tend to develop a slightly lop-sided, or unsymmetrical body. But notwithstanding this obvious drawback, it is nevertheless true that games furnish the best kind of exercise for both boys and girls.

A word or two may here be said about military drill. Military drill gives exercise to the muscles; but as for muscular exercise for boys and girls, neither military drill nor gymnastics are so good as lawn tennis, baseball,

lacrosse, football, basket-ball, or other games in which they are interested. It is true that military drill makes pupils walk erect, inculcates prompt obedience, and develops uniformly most of the muscles of the body; but drill should not be practised by pupils to the exclusion of exercises which they plan for themselves.

One very great advantage of games over routine drill, whether military or gymnastic, is that they exercise both mind and muscles; whereas drill and class gymnastics, once they have been learned, exercise the muscles only.

To sum up, exercise of the muscles may be used for two or three very different purposes:

In the first place, it may be used to strengthen certain muscles of the body; as, for example the muscles of the back, so as to prevent a person from being round-shouldered.

In the second place. exercises may be used to remedy a faulty carriage or an awkward gait. But only a few boys and girls need exercises to correct either of these defects, because only a few have them

In the third place, we may exercise both muscles and mind in sports for the sake of taking care of our health—a purpose quite different from the other two. Along with such sports we may include the healthful practice of exercising the muscles for ten or fifteen minutes every morning before dressing, and also all exercises that will give us pleasure and at the same time call into play the faculties of the mind.

And if, in taking exercise in any way we strive with others and try to excel, no harm will be done so long as we do not carry the struggle too far. The important

matter is to get the exercise, while all the time we keep the mastery over ourselves, and do not overstrain our nerves and muscles, thus bringing on disease of the heart, blood-vessels, or other organs.

But in order to keep in good health, not merely must we have exercise of the muscles, we must have rest of the muscles and rest of the brain as well. Now the best rest for both is sleep.

How much sleep should we have? The number of hours will vary with the individual. Young people need more than adults. Children of ten and eleven years of age should have about eleven or twelve hours; older children, from nine to ten; and grown-up people, from seven to eight hours. The aged and delicate require more sleep than the strong.

Young people are not usually troubled with sleeplessness; but it is well that they should know how to avoid it. In the first place, they should take plenty of exercise in the fresh air, which is almost the same as saying that they should not work long hours at any indoor occupation. Nor should they worry over their work after leaving the school, office, or factory.

There should be a fixed hour for going to bed every night and for getting up in the morning. The bed should be clean and somewhat hard, and it should have a low pillow. It is better to lie upon either the right or the left side, than upon the back. The foot of the bed should be nearest the stove or other source of heat, and the window should be open all night—more widely in summer than in winter. Neither cold air nor night air can do harm, if one is covered with plenty of bed-clothes.

In very cold weather a light cap should be worn, to avoid the danger of catching a cold in the head. If you follow all these rules and are still troubled with sleeplessness, it is time for you to consult a physician.

Again, some people who have been much troubled with sleeplessness have taken drugs known as "sleeping powders" in order to get sleep. But the danger of forming the habit of using sleeping powders is very great, and, when once the habit has been formed, it is very hard to fall asleep without their use. As time goes on, the users of these drugs find that they have to take more and more of them, until finally their health is destroyed. No sleeping powders should ever be used except by the order of a physician.

CHAPTER XXIV

CLOTHING

When warming yourself in the sun, did it ever occur to you to ask how the heat travels from the sun to the earth? Or have you ever considered how heat passes from the stove at one end of the school-room to the other end?

With a little help from your teacher you will learn that heat is lost from the school stove in at least two ways In the first place, the heat warms the air above and around the stove, and this warm air rises to the ceiling and spreads throughout the room. This way of spreading heat is known as "convection". In the next place, some more heat is lost by the stove sending it out

in straight lines, "radiating" it we say, in all directions, just as the sun does when his warm rays reach the earth.

Now, our bodies also lose heat by convection and radiation, and in two other ways besides; namely, by the drying up or evaporation of the sweat which comes out on the skin, and by the heat passing through our clothing from the skin to the outside. This latter and fourth way of losing heat is spoken of as "conduction".

You may understand what is meant by conduction of heat if you simply place one end of a long iron poker in a fire and note how the heat slowly travels from the end that is in the fire away out toward the other. In the same way, some of the heat of the body warms the clothing that is next the skin and then slowly travels outwards through the clothing toward the air.

Of course, the speed at which the heat travels from the skin outwards will not be always the same. It will vary with the kind of clothing we wear, just as the speed at which heat travels along a wire varies with the kind of metal; for heat is conducted along a copper wire faster than along an iron one. And in much the same way the heat of the body will travel to the outside air through cotton or linen clothing faster than through wool or fur.

It has, accordingly, been found that linen and cotton are the most suitable for summer clothing, because they are cool, that is, because they quickly conduct the heat away from the body; while wool and fur are the most suitable for winter, because they are warm, that is, because they keep in the heat of the body.

We must remember these facts about the conduction of heat, because the suitability of any clothing material depends largely upon its power of preventing the heat of the body from escaping. As the temperature of the human body is 98.4° F., while that of the air in this country is rarely higher than 90° F., it follows that the inside of our clothing is usually warmer than the outside. We must, therefore, always wear clothing which is suited to the season. The best material for underclothing at least is wool for both winter and summer, a heavier weight being used in winter and a lighter in summer.

Whether for winter or for summer use, clothing should always be as light as possible. Some people have an idea that clothing should be light for summer use and heavy for winter. But the fact is that clothing of heavy but good conducting material may not be so warm for winter use as light clothing made of non-conducting material.

Of course, when it is very cold, fur is the best clothing, because the wind cannot pass through the skin part. But excepting in extremely cold weather, and in rainy weather when we wear waterproof material, clothing should be porous in order to allow the sweat to evaporate freely.

Clothing should also be loose. Tight gloves and tight shoes lessen the quantity of warm blood which goes to the hands and feet, and, as a consequence, we suffer from the cold. In the same way, tight clothing tends to make the body cold in cold weather.

Similarly, tight hats and caps impede the circulation of the blood to the scalp and cause baldness; and tight

collars impede the circulation to the head and cause headache. Tight belts, waistcoats, or waists lessen the size of the lower part of the chest and of the upper part of the abdomen, thus seriously interfering with the healthy working of the lungs, heart, stomach, and intestines, and causing sometimes life-long suffering. In young people the narrowed waist is generally the forerunner of indigestion, weakness, nervous debility, and consumption. So important is this matter of loose clothing thought to be in England, that, in some of the largest and best boarding-schools, the boys are not allowed to wear waistcoats and belts at all.

Not merely should clothing be loose, but, as has been said, it should be as light as possible, and such weight as

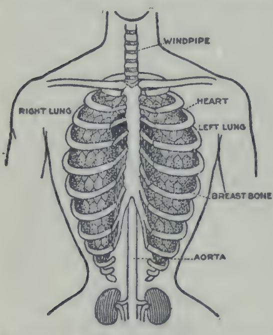


FIGURE 45.—The effect of tight clothing on the chest.

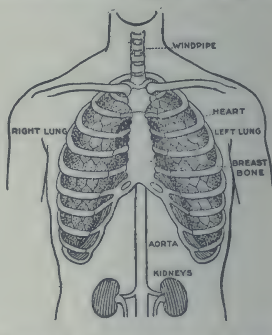


FIGURE 46.—Natural shape of chest.

it possesses should be borne mainly by the shoulders. Heavy clothing that is carried by bands round the waist tends to displace the internal organs and bring on disease.

The aged, the delicate, and the very young should wear thin under-flannel the year round—dry, loose, and warm.

One reason for wearing it in summer is that it generally prevents the bad effects of sudden changes of temperature.

We should never keep on under-garments that have become damp with either rain or sweat, because the evaporation of the moisture, whether rain or sweat, chills the body. Wet garments should be changed for dry as soon as possible. If this cannot be done, we should not sit down in them, especially if a wind is blowing; but should rather walk about until they are dry.

Once more, clothing should be warm enough to keep us from catching cold. Many young people expose their necks to cold winds in winter, and, as a result, catch cold in the nose or the throat. The redness, swelling, and pain which may result, indicate that these parts are weak and unable to throw off the effects of disease germs. In very cold weather, therefore, every person should wear a muffler or other adequate protection for the throat. A succession of colds generally brings on chronic catarrh—a diseased condition of the nose and the throat which causes a very offensive breath. A cold, of course, never gives us consumption or any other disease; but it alters the juices or watery secretions of the nose, throat, and windpipe, so that they no longer kill disease germs, as they do when we are in good health.

For more than half the year some kind of footwear is an absolute necessity in our climate in order to keep the feet warm. But the selection of boots and shoes rarely receives much attention. Quite frequently children make

their own selection, and do it so badly that a great deal of discomfort is the result. Ill-fitting shoes worn by children for several years show the effects of slight, steady pressure in changing the shape of the foot. As a rule, the pressure is never great enough to cause much pain. The child does not say that the shoes are hurting his feet. But the pressure applied day after day, for months and years, slowly presses the big toe over toward the outer side of the foot and away from the straight line in which it always lies in the infant. Sometimes the little toe also is pressed toward the inner side of the foot. These two changes, one in the big toe and the other in the little toe are always the result of wearing boots or shoes with narrow toes. So much have our feet been altered by the pressure of ill-fitting boots or shoes, that it is a rare thing to find a man's or a woman's foot well-shaped.

What should be the shape of a shoe which would not alter the shape of the foot? No doubt, different shoemakers would answer this question in different ways. But surely a common sense way of determining the right shape would be to say that the outline of the natural foot should determine the outline of the well-fitting shoe.

FIGURE. 47—Infant's feet.

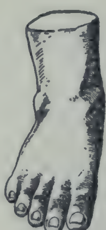


FIGURE 48.—Adult foot.

If we covered the whole of the sole of the foot with printer's ink, or some kind of soft paint, or even water, and then planted the foot upon a sheet of white paper, placed on the floor, we should get a shape, not of the outline of the whole foot, but of those parts of the foot which press upon the paper. If then we drew a line around the outside of the figure thus printed upon the paper, we should get the correct shape for the sole of a shoe.

If we determine the shape in this way, then it will differ somewhat from that given by most shoemakers. The outline will be curved inwards much more on the inner side, and curved outwards much more on the outer side of the foot. A shoe shaped upon this outline will take into account those parts of the sole of the foot upon which the weight of the body falls, as well as the arch of the foot on its inner side upon which no weight falls. If we shape the sole of our shoes upon the outline which the foot prints upon a sheet of white paper, we shall certainly get a shoe of better shape than the shoemaker gives us in his sharp-pointed boots. Figure 49 shows the proper shape of a boot, whether for a man or for a woman.

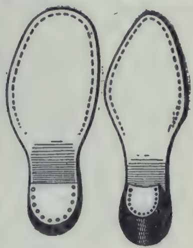


FIG. 49. FIG. 49 (*a*). Two different shapes for the sole of a boot. Which should you select? Why?

It is only right, however, to say that within the past few years considerable improvement has been made in the shape of children's footwear. The so-called leather sandals are much to be commended for summer wear. Their shape is like that of the foot, while their coolness

and facility for ventilation and evaporation through the openings in the leather leave little to be desired.

FIGURE 50.—High heel boot.

Improvement in women's footwear has not kept pace with that in children's. In the case of the former the most objectionable features are the high heel and pointed toe. The effect of the high heel is to thrust the foot toward the toe of the boot, thus displacing both the big toe and the little one and producing corns and bunions. A further objection is that the weight of the body is thrown largely upon the toes.

CHAPTER XXV

CARE OF THE EYES AND THE EARS

The eyes of every child who does not show evidence of good eyesight should be examined by a competent eye specialist.

If you have headaches in school, often toward the noon hour or toward four o'clock in the afternoon, they are likely to be due to some trouble in the eyes. Of course, this is not always the case. The trouble may lie in some other part of the body; but it is always safest, when troubles like these are noticed, to have a doctor examine the eyes and find out what is wrong.

You must be careful not to catch any disease of the eyes from other persons. There are some bad diseases

of the eyes that may be caught by using water, towels, or handkerchiefs that diseased persons have used, or by touching some parts of a diseased person's body with your fingers and afterwards rubbing your eyes with them. These diseases are caused by germs, such as will be described later on.

Have you ever heard of snow-blindness? It comes upon people who have to travel a long distance over stretches of glistening snow, as when one crosses a northern prairie in winter. The same kind of trouble comes upon people who travel across the Sahara desert. The long stretches of white sand in Africa and of white snow in America, reflect the light so strongly into the eyes that after a while the nerve endings lose all power of doing their work, and the traveller becomes temporarily or permanently blind.

It is part of the religion of a Mahommedan Arab not to shade his eyes in crossing the desert, and for this reason as well as from lack of cleanliness, there is more eye disease among these Arabs than among other people. They do not wear caps or hats like ours, with peaks or brims on them which help the eyelids to keep out the painful glare of the sun; consequently, the nerve of the eye is sometimes slowly killed by the intense light, and at last blindness comes on.

FIGURE 51.—Arab's head. Eyes unshaded.

We should remember these facts, if we would avoid injuring the eyesight of babies. Very often a thoughtless

mother may be seen pushing her baby along in its carriage and allowing the strong light of the sun to shine full into its eyes. This is very wrong. Of course, when the baby grows older and stronger, it will do no harm to have the sun shine into his eyes now and again; but, when he is quite young, his eyes should always be shaded from very strong light, because the nerves of the eye are delicate and might be injured, just as those of a man's eye are sometimes injured in travelling over the snow or sand.

FIGURE 52.—Baby's eyes should be properly shaded while it is out getting fresh air.

A steady, bright light is the best for reading or writing at night. Flickering, unsteady lights, like those from candles, gas-jets, or arc lamps, are trying to the eyes. Again, if you are too far away from a light, when you are reading at night, and the print cannot be clearly seen, almost without knowing it you bring the book close up to your eyes. This throws a double strain upon them, the cause of which you cannot understand just now; but you may be quite sure that steady reading or doing fine

work of any kind is bad for the eyes even in daytime, and very bad at night unless the light is bright and steady.

If you have sore eyes or weak ones, or have pain in them, or cannot see clearly to read, or cannot clearly see well-known things at a distance, then there is something wrong with your eyes, and you should go to an oculist and have them tested, so as to find out what the nature of the defect may be.

If you have to hold a book nearer the face than twelve or fourteen inches in order to see distinctly, you are near-sighted and should wear glasses. If you have to hold the book farther away than seventeen or eighteen inches, you are far-sighted and need glasses, and these should be procured as soon as possible, so as to relieve the "eye-strain" which must otherwise be the result.

No small objects, such as beans or peas, should be put into the ear; nor should hard wax be allowed to remain in it. Accumulation of wax in the canal of the ear impairs the hearing. It can usually be removed by gently syringing with warm water.

In caring for the ear, perhaps the most important thing is to avoid the effects of a severe cold. A prolonged cold in the throat should never be neglected; because the effect of the cold is to irritate the surface and make it a suitable soil upon which the germs of infectious disease may grow. From the throat, the disease may spread up the Eustachian tube into the ear, and, as a result, an abscess may form in the middle ear, and then there is danger of its spreading to adjoining cavities in the bone. If this occurs, not merely may the hearing be impaired, but the life of the person may be endangered.

CHAPTER XXVI

THE STRUCTURE OF THE NERVOUS SYSTEM

The nervous system is the great governing power of every part of the body. It starts, controls, and stops all muscular movements; it determines whether glands shall secret their juices or not; it regulates the flow of blood to the different parts as may be needed; it receives messages from, and sends out messages to, every part of the body; it gets from the eye, ear, skin, mouth, nose, and muscles information of objects and facts in the world around us; it stores these as memory; and it decides upon present and future conduct.

Not only, therefore, is the nervous system the governing power of the body, but it is also the seat of intelligence, will, and reason.

For convenience of description, it may be said to consist of three parts:

1. The brain, including (*a*) the cerebrum or large brain, and (*b*) the cerebellum or small brain. The cerebrum is partly divided into two halves or hemispheres by a deep fissure which runs from front to back along its surface.

2. The bulb and the spinal cord, the latter being a large, thick tube about the size of the forefinger, running from the cerebrum down the greater part of the length of the trunk, and inclosed for safety in the backbone. The bulb is the upper enlarged end of the cord where it joins the brain.

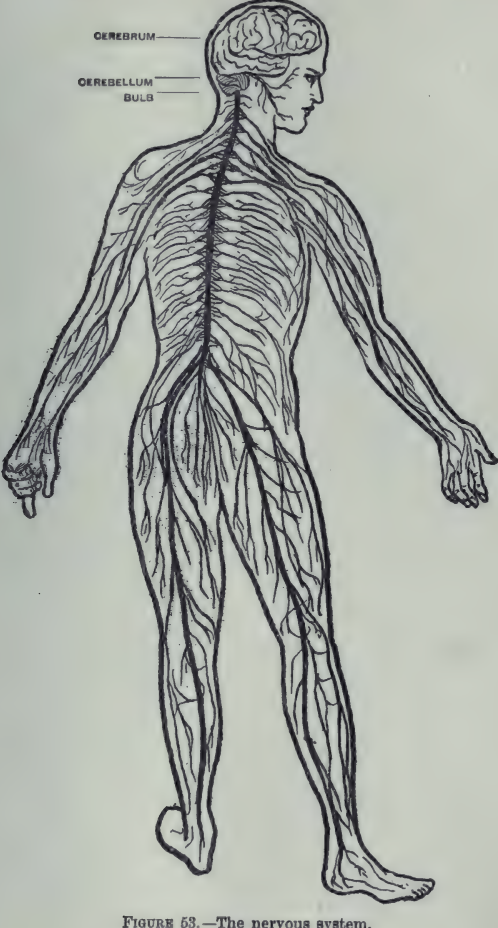


FIGURE 53.—The nervous system.

3. Twelve pairs of nerves, or rather bundles of nerve-threads, which grow out from the brain and the bulb, and thirty-one pairs of similar bundles which grow out from the spinal cord. These forty-three pairs of nerves branch and re-branch very much, and are distributed to all parts of the body, internal and external.

The outer part of the brain is grayish in colour, and is, therefore, called the gray matter. The surface is marked with rounded ridges and fissures between them which vary in depth from one quarter of an inch to one inch. Below this gray matter, the brain substance consists of white matter, so called because the fibres or threads of which it is composed are white in colour, and very similar to the nerve-fibres in other parts of the body.

The fibres of the white matter are used either in receiving nerve messages from various parts of the body, or in transmitting messages from one part of the gray matter to another, or in sending messages from the brain out to muscles, glands, arteries, etc., in different regions of the body.

The nerve-fibres of the nervous system have often been likened to the separate wire of a telephone or telegraph cable. Just as each separate wire in a telephone cable can transmit a separate message, so each separate thread, or fibre, in a bundle of nerves, carries its own message to or from the brain, or to or from the spinal cord.

By a study of certain diseases of the human brain as seen among patients in a hospital for the insane, and by experiments upon the brain of some of the lower animals, physiologists have discovered that certain

parts of the gray matter are connected with the special senses—sight, hearing, taste, touch, and smell.

By similar methods of study it has been discovered that the voluntary movements of the body are all controlled from other areas of the gray matter. In other words, the surface of each half of the brain has been mapped out into areas, some of which are concerned with receiving messages from the different

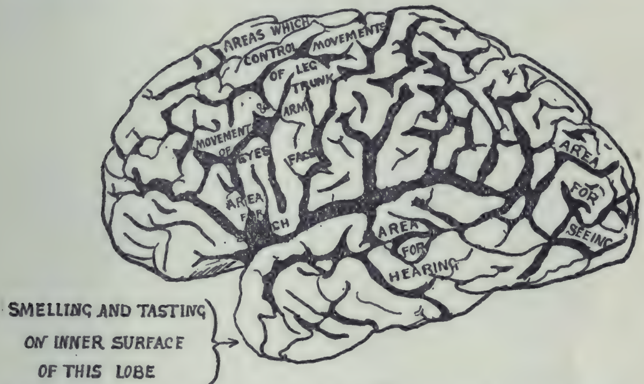


FIGURE 54.—Side of the cerebrum showing the "Sensory Areas" or areas connected with the senses. Also the areas connected with movement, that is, the "Motor Areas". The dark lines denote the fissures in the gray matter.

senses, and others with sending out messages to the muscles which control the voluntary movements of the eyes, head, trunk, and limbs.

The areas which are concerned with voluntary movements, that is, the "motor areas", are, roughly speaking, triangular in shape for each half of the brain. The bases of each pair of triangles are upon the mid-line of the brain, and the other two sides extend downwards to points about half-way between the ear and the eye at each side.

From the gray matter of these areas, nerve-fibres extend down through the brain and run out along with the large nerves of the brain or spinal cord, ending finally in the voluntary muscles of the body. Every muscle is supplied with nerves which branch and re-branch throughout every part of it.

When we *will* to move any part of the body, the eyes, for example, messages start from the special area in the brain for movements of the eyes, pass downwards and out along three nerves which leave the brain, and, on reaching the eye muscles, produce contraction of these, and, consequently, movement of the eyes in the direction in which we wish them to move.

Or, to take another example. In the case of the forearm, when we *will* or command the muscle to bend the elbow, the command passes as a message from the motor area of the brain down the upper part of the spinal cord, and out along a nerve to the arm. Branches of this nerve enter the biceps muscle, and, as a result of the nerve message reaching this muscle, it contracts, and the arm is bent.

The proof of this connection of muscle and nerve is one of the great discoveries in physiology, and was well known over two hundred years ago.

It would appear from the foregoing that there are two different kinds of nerve-messages or nerve-impulses passing to and fro all the time throughout an animal's body. One set of messages are passing from the special sense organs, the skin, and other parts of the body, inwards to the spinal cord and brain; and a second set are passing from the brain, or spinal cord, outwards to muscles, glands, or other organs.

If we cut the nerve which carries an ingoing message, such a message cannot reach the brain or cord, and we have loss of feeling known as "sensory paralysis". If we cut the nerve which carries an outgoing message, then such a message cannot reach the muscle, it does not contract, and is, therefore, said to be paralyzed. A muscle that is cut off permanently from its nerve supply shrinks up and after some time loses its power of contraction.

The muscles of idiots are seldom, if ever, symmetrically developed, because the brain is not perfectly developed and does not, therefore, send out the nerve-impulses which alone will make the muscles grow. Such persons all walk, if they are able to walk at all, with an unsteady or shuffling gait.

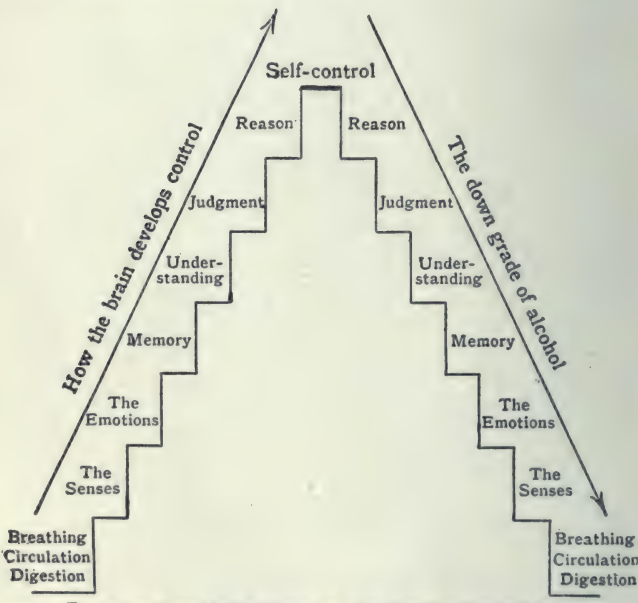
On the other hand, amputation of the leg of an infant is followed by arrested development of certain parts of the brain. The parts affected in this case are the "motor areas" for movements of the leg and foot. If the eyes are destroyed, another part of the brain fails to develop properly, namely, the area for vision.

CHAPTER XXVII

ALCOHOL AND THE NERVOUS SYSTEM

We have seen that a vast number of nerves run from the eye, ear, nose, mouth, skin, muscles, and joints, and carry messages to the brain and spinal cord every second of the day. Some messages are stored away for future use. When you were made to learn the letters of the alphabet, the names and meanings of a vast number of

words, tables of numbers, facts of history and geography, and all the thousand and one things which you have to learn in school, your brain was storing up messages for future use. But besides receiving and storing messages, the brain has all day long to be originating and sending out messages as well. They travel at the rate of 98 to 131 feet per second, about the rate of our fastest express trains. No "central office" of any telephone company in the land is so busy as the brain is in receiving, storing, and sending out messages.



THE UP AND DOWN GRADE; HOW WE CLIMB AND HOW WE MAY FALL.

FIGURE 55.—Taken from "Alcohol and Life" by permission of The Macmillan Company of Canada, Limited.

In fact, the work of the brain and nervous system is never done from the time we wake in the morning until we go to sleep at night. During this time it is important that the brain should be kept free from anything that would hamper its work. If alcohol is drunk, it mingles first with the blood, then with the lymph, and, finally, bathes all the tissues and organs of the body. The poison begins to affect the delicate mechanism of the brain, so that messages are received and sent out more slowly and less distinctly. This may produce serious consequences.

For example, when a man who is near a railway crossing sees and hears an express train coming, a warning message is sent from his eye and from his ear to the brain. Quick as a flash, the brain sends a message in reply to the muscles of the legs, so that the man either halts on one side of the track to let the train pass or hastens across. But if his nerves have been blunted and deadened by alcohol, the transmission of messages in his body is retarded; he is not able to judge properly of the speed of the train or how far away it is. He does not realize the risk he is running, and an accident may result. In fact, the main effects of alcohol are due to its action on the brain and nervous system.

Let us look for a moment at the way the human brain develops. A man thirty years old looks quite unlike a new-born baby, and his brain, too, has a very different structure from the brain of a child. During all the years that the organs and muscles of his body are developing, the brain areas which control these organs and muscles are also growing.

Roughly speaking, we may say that the first organ which develops is the brain, next the alimentary tract, and then the heart. As the nervous system develops, it gradually controls all the functions of the body.

Before many months the child learns to walk—that means further progress has been made in the development of his brain. Then he begins to learn things by seeing, hearing, touching, and smelling. He is acquiring knowledge and his brain is growing. The highest power which the brain acquires is the power which has to do with restraining a man from acting or speaking in a way that he should not. This power it is that whispers "don't" when you feel like being ill-tempered or naughty. It is this power of self-restraint or self-control which chiefly distinguishes men from the lower animals.

In thus describing the order of development, it must not be imagined that these areas of the brain are built up one on top of another like bricks in a building. The development of many of these areas is going on at the same time, and they overlap in a marvellous way. For the sake of simplicity, however, we have disregarded this fact.

Now when alcohol is taken into the system it gradually destroys the highest results of previous development. Long before the drinker appears to the ordinary observer to be drunk, some of his nerves are partially paralyzed, and so he has less strength and stability in the face of temptation. Besides losing some of his natural reserve, he is likely to say and do things that he would never have said or done in his normal moments. He becomes unable to distinguish clearly

between right and wrong. The fine edge is taken off his moral nature, and he may become untruthful, dishonest, or even criminal.

Moreover, the quantity and quality of his mental power will be affected by alcohol, as we shall see later. Such a man is more dangerous than the man who is obviously drunk, because he appears to be all right and is depended upon, when he should not be trusted at all.

If still more alcohol is taken, it attacks the other powers of the brain. The memory becomes affected, and the drinker forgets an important appointment. Next, if he continues to take alcohol, he loses control of his emotions and may become violently angry, foolishly affectionate, or absurdly jealous. In the end, if the use of alcohol is continued, the cerebral control becomes further impaired, and the drinker is rendered unable to walk. He staggers, rolls, and falls. He is reduced to a state where, though his heart and lungs still function, he is little better than a brute.

It will readily be understood, then, that the man who uses alcohol reduces his chances of success in business and in industrial life. Neither his muscles nor his brain can do their work as well as those of an abstainer. The habit of drinking tends to lessen his endurance, to impair his skill, and to cause more accidents and sickness. The drinker who loses time because of his drink brings loss upon his employer not only for his own time but for that of other workmen. In a well-managed factory, each department is supposed to turn out daily a certain number of parts for the next room to finish. If two or

three men are absent from their department, valuable machinery stands idle, the work expected is not finished for the next department, and so the routine of the whole factory may be more or less disorganized.

Not only is the drinker likely to lose time through absences, but he unfits himself for doing efficient work even when he is in the office, factory, or field. He is not mentally alert; his accuracy is not so great as in normal persons; he loses his sureness of hand. In fact, the greater the skill required in doing a piece of work, the more will the work suffer impairment if alcohol is taken.

The man who uses alcohol is more liable to accident, sickness, and disease. In England and Australia there are large sick benefit societies, the members of which are abstainers. When the records of these societies were compared with the sickness of those benefit societies that did not require abstinence, the members of the abstaining societies were found to have been away from work on account of sickness on an average of 6.4 weeks; the drinkers lost on an average 10.9 weeks—four and one-half weeks more.

Because of decreased ability to work steadily and efficiently, the user of alcohol earns less money than the abstainer. His family is likely to be poorly provided for, improperly clothed and fed, and lacking in high ideals.

CHAPTER XXVIII

HOW MICROBES GROW

Microbes, whether plants or animals, can be seen only with the aid of a powerful magnifying glass; and, in case you have no such instrument in your school, I must try to give you some idea of how these germs live and how they spread. This I can do best by asking you to call to mind many things which you already know about big plants and big animals.

FIGURE 56.—The large circle stands for a cross-section of a fine hair $\frac{1}{1500}$ of an inch in diameter. The small circle in the centre stands for the diameter of a red blood cell $\frac{1}{3200}$ of an inch. The three short lines represent bacilli, and the four spherical dots represent cocci, $\frac{1}{25000}$ of an inch in diameter.

We shall begin with some plant germs first, because they are the ones which are best known and which have been most carefully studied.

Did you ever notice a gray or green covering on a piece of stale bread or old cheese? If you have, then you have seen a mass of plants or moulds which belong to the same class as the plants known as bacteria. You will find them growing also on rotten fruit that has been kept in damp cellars. Often they may be seen growing on garbage in shady backyards, or on the manure heap in barn-yards; but always in the shade. Sunshine and dry air kill the moulds.

Sometimes they may be found growing on boots, shoes, and clothing in houses that have been closed

FIGURE 57.—Mould from cheese, much magnified. The little round knobs contain the tiny spores, or seeds, of the plant.

up for some weeks in summer. When you go into such houses, they smell musty, and if you look closely at the furniture, especially in the dining-room and kitchen, you will find a fine gray bloom on almost everything—chairs, tables, floors, walls. No wonder the house smells musty. When a family has been away for two months, every door locked and every window fastened, where have all the tiny plants come from that are found in every part of the house? Clearly they must have grown

from the spores. But where did the spores come from?

The spores are very small indeed. Even when you look closely at mouldy bread, you cannot see any of them. You must use a magnifying glass. With its aid they may be seen as small, round bodies like little balls, and they hang in clusters on the fine, threadlike stalks of the mould plant.

When the spores are ripe they fall off, and, being very small and very light, they float about in the air, like fine specks of dust in a sunbeam. The slightest draught of air carries them through the house from room to room. As a result, they are to be found all over a house, especially if it stands in a shady place and the air is damp.

These facts about moulds will help you to see that you already know a good deal about bacteria. Because, as bacteria are plants of the same class as moulds, they must grow and spread and live somewhat like them. For example, they must grow from invisible seeds, just as apples, or plums, or wheat, or barley grow from visible seeds. Only we do not speak of the invisible seeds of bacteria and mould as seeds; we speak of them as spores. The tiny plants themselves, or their spores, float about in the air, and, when they fall upon a suitable soil, such as a piece of old bread, or meat, or jam, they begin to grow and soon produce a big crop of fresh mould and plenty of new spores.

Most kinds of bacteria will not grow upon glass, or pure sand, or in pure water. Like all plants they will grow only when the soil is favourable. Every farmer

knows that it would be of no use to sow wheat upon a rock or upon clean sand. It would not grow on such places.

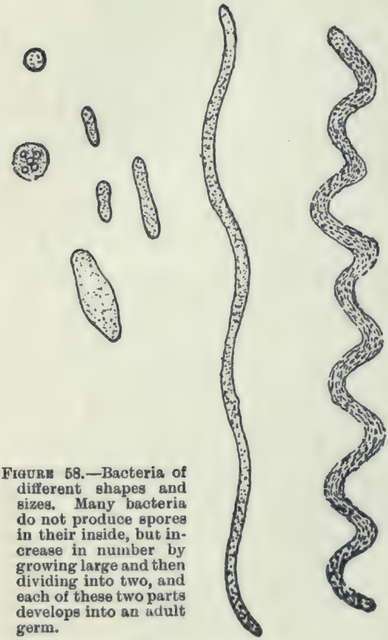


FIGURE 58.—Bacteria of different shapes and sizes. Many bacteria do not produce spores in their inside, but increase in number by growing large and then dividing into two, and each of these two parts develops into an adult germ.

The kind of soil on which bacteria grow varies much according to the kind of bacteria. Some kinds grow upon wood; some in earth; some upon rocks; some upon the teeth; some grow upon the scalp; some upon the skin of the body; some upon the covering of the inside of the nose, mouth, or throat; some upon the lining of the windpipe, or in the lungs; some in the food while it is in the stomach or bowels; some upon the lining of the bowels; but wherever they grow, it is only on soil which is suitable for their growth. Warm milk is one of the best soils for bacteria.

Again, other things must be suitable as well as the soil. You know that farm crops must have sufficient rain and warmth before they will grow well. And, in the same way, bacteria must also have a certain amount of moisture and warmth to make them grow well. Indeed,

if some bacteria or the spores of others are kept perfectly dry, they will lie for years without growing.

Then, again, if bacteria are kept very cold, they will not grow, no matter how suitable the soil may be on which they are lying nor how long they may lie there. For example, some kinds of bacteria cause the decay of meat by growing on its surface. But this growth will take place only when there is warmth enough to suit these plants. If the meat is kept frozen, bacteria will not grow upon it any more than wheat will grow upon frozen soil. In fact, as you probably know very well, meat may be preserved long enough to be carried from Australia to England by simply keeping it frozen during the voyage. This is what is meant by carrying meat or fish in "cold storage". But, just as seeds begin to grow in the spring when the weather turns warm, so, the moment frozen meat is thawed, the bacteria begin to grow on its surface and the meat begins to spoil.

FIGURE 59.—The white spots denote groups of bacteria which grew from filthy milk. The plate on which these were growing was covered with a circular piece of cardboard in which the letters MILK were cut. It was then exposed to the sun, and the sunlight killed all the bacteria that were exposed.

You have already been told that moulds grow in the shade. So most bacteria grow best in the shade.

Many bacteria are very useful in nature, for they change dead wood and the dead bodies of animals into dust. If

it were not for these bacteria, no matter would ever decay and disappear, and life would be impossible. Other bacteria are found upon clover roots, and in growing on the roots they actually make the soil more fertile by taking the nitrogen from the air and fixing it in the soil for the clover plant to live on. Then again there are other useful bacteria. For example, the best qualities of butter and cheese cannot be made without certain bacteria. Some of these bacteria are grown by scientific men and sold to butter-makers and cheese-makers, in order that they may be certain to make good butter and cheese in their factories.

CHAPTER XXIX

HOW MICROBES GROW (*Continued*)

A very interesting thing about disease germs is that they flourish better at some seasons of the year than at others. Just as we find some plants like anemones and hepaticas producing their seed in the spring; strawberries and timothy producing their seed in early summer; wheat and oats theirs in July and August; and pears and apples theirs in October; so we find disease-producing bacteria developing and causing disease, some at one season, some at another.

For example, diarrhœa, which is due to bacteria in the bowels, is most frequent in hot weather, while, on the other hand, the number of cases of disease of the windpipe, bronchial tubes, and lungs, also due to bacteria, slowly increases from June to January. In the latter month

there are four or five times as many people suffering from throat and lung troubles as in June.

There is a twofold reason why throat and lung troubles, and diseases like diphtheria and small-pox, are so much more prevalent in cold weather than in warm. In the first place, the cold is depressing to the health of many children and delicate people, and renders them more liable to catch infectious diseases; and, in the second place, both sick and well people are more confined to their homes, so that disease germs spread more readily from one inmate to another.

The accompanying chart shows the variations in diphtheria in the different seasons:

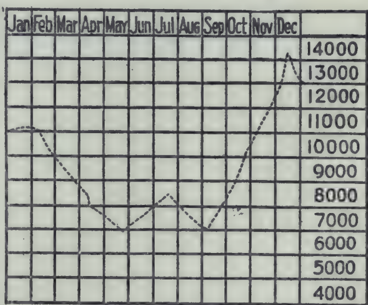


FIGURE 60.—The dotted line shows the variation in the number of cases of diphtheria among school children between the ages of five years and fourteen years during the years 1900-1904. The numbers in the right express the number of cases. Computed from the United States census report.

In one other point bacteria resemble big plants. As you know, after seeds are planted in the spring, they remain in the soil for some days before they show any signs of sprouting; but if the soil is moist and warm, the seeds are in reality growing all the time, though they show no signs of coming up. In almost precisely the same way disease-producing bacteria remain some time in the body before they cause any marked signs of the disease. The time during which the germs appear to lie quiet in the body

is known as the period of incubation. This period varies much in different diseases, as you will see from the following table:

	Time from Exposure to First Sign of Disease		Time from Exposure to First Sign of Disease
Measles	7-14 days	Whooping-cough	7-14 days
German Measles	10-14 "	Mumps	7-21 "
Diphtheria	1-8 "	Chicken-pox	10-14 "
Malarial fever	10-30 "	Scarlet fever	1-7 "
Influenza	24-48 hours	Small-pox	12 "
Typhoid fever	10-14 days		

So you see that bacteria resemble big plants in several particulars:

1. They grow only upon suitable soil.

2. They require warmth and moisture in order to grow.

3. Some of them grow best in the dark.

4. Some grow best in sunlight.

5. They appear to be quiet in the body before showing any sign of growth—the incubation period.

6. Some of them multiply by the parent plant dividing into two tiny baby plants, each of which may grow into parent plants again; others of them multiply by forming spores inside of the parent, as shown in Figure 58, and these spores may grow into adult bacteria.

CHAPTER XXX

HOW GERMS ARE SPREAD

Let us now try to understand how disease germs are spread. But first let me ask you how plant seeds are spread.

You have often seen the downy seeds of the dandelion and of the thistle carried along in the wind. Or you may have noticed burs sticking to the hair of a dog, the wool of a sheep, or the tail and mane of a horse. The hard seeds of currants and berries are often seen in the droppings of birds. On one occasion Charles Darwin got no fewer than eighty seeds to sprout from a small piece of mud which he had removed from the foot of a passenger pigeon. In all these cases, seeds may have been carried a long distance from the plant or shrub on which they grew. The seeds of many common plants are also scattered by winds, waves, tides, streams, animals, ships, and railway cars. Now, just as plant seeds are always transferred from the parent plant in various ways to suitable soil, so are the seeds of an infectious disease always transferred from a man, woman, or child who is ill, to others who are not ill.

Ten years ago we believed that air, water, soil, and food could of themselves be sources of infection; to-day we know that they are not. We believe that our environment or surroundings, that is, air, earth, water, and food may convey disease to us; but have good reason to believe that man, and to a much less extent some of the lower animals, are the only sources of disease germs.

You must be careful to distinguish between the source of infection and the transference of infection. The latter phrase refers to the different modes or ways in which microbes may be carried from man to man or from an animal to man.

For example, in human tuberculosis or consumption, man is the source of infection, and tuberculous sputum from his throat or lungs is the usual mode of transference. In a case of bovine or cow consumption, the source of infection is the cow, and the mode of transference is cow's milk. Similarly, in the case of plague, the source of infection may be a diseased rat, and the mode of transference may be a rat flea which first bites the diseased rat and afterwards bites a man.

You must remember, too, that we often use the phrase "channel of infection" to mean the particular path by which the germs enter the body. Thus they may enter (1) by the respiratory tract, or (2) by the gullet and intestine, or (3) through a cut or abrasion of the skin, or (4) by the eyes, or (5) by the urinary passages. Accordingly, when you see your first case of a communicable disease, I would have you ponder much over the questions:

(1) Where did the germs come from?

(2) How were they transferred?

(3) By what avenue did they enter the body of the patient?

In perhaps nine cases out of ten, the germs are transferred directly from a diseased person to a well person, as in kissing. Or they may be transferred indirectly by soiled hands, infected towels, cups, spoons,

forks, toys, remnants of food, or other objects which have recently been mouthed or handled by an infected person.

Special mention must be made of one source of infection, namely, by those who are known as "carriers". These are persons who carry the disease on or in their body, and yet are not sick. Thus a child may have the germs of diphtheria in his nose and throat, and yet be in good health; or he may carry the germs of pneumonia in his mouth, or typhoid in his intestines, and show no signs of either disease.

It is the carriers of disease that render it difficult for a public health officer to trace the source of infection or to stamp out an epidemic of any kind. Typhoid, measles, scarlet fever, and influenza are sometimes so mild that those having these diseases do not consider themselves sick. They may go to school or church, may ride in the street-cars, attend theatres, and continue their usual occupations in shops, factories, bakeries, or butcher shops, and thus spread infection throughout a whole community.

Since a sick person is the great source from which infection spreads, you can easily understand that one of the best means of checking the spread of a communicable disease is to confine the patient to one room until he is perfectly well. This is known as "Isolation". The benefits of isolation vary greatly according to the manner in which it is carried out. We get the best results when a patient is confined to one room with a trained nurse; the results are not so good if the nurse is untrained; and the results are not at all satisfactory

if there is no room for the exclusive use of the patient.

Some parents think that, when one child in a house takes scarlet fever or diphtheria, they can prevent the disease from spreading to other children by simply

FIGURE 61.—A crowded street-car helps to spread an infectious disease throughout a city.

keeping the sick child in one room. And, indeed, they might do this if they were very careful. If the mother or nurse never left the sick room; if the door were kept closed or carefully screened all the time; if every article that left the sick room each day were first disinfected with strong chemicals or in boiling water; if, after the child was well, the room and everything in it—floor, walls, windows, furniture, carpet, curtains, and bed-clothes—were also thoroughly disinfected; and, finally, if the child and nurse were first bathed, and then passed to an adjoining room, and there supplied with a complete change of perfectly clean clothes, there would be some

chance of confining the disease to one child in the family.

Many parents are foolish enough to think that all this care is unnecessary. They, therefore, neglect some of these precautions, with the result that the disease spreads to every child in the family.

Not many years ago, when any communicable disease was spreading through a family, kind neighbours used to visit the house and help to nurse the sick; and not knowing how communicable diseases are spread, these neighbours would return home without ever once thinking about disinfecting their clothes or washing their hands and faces. In this way they carried the disease germs to their own homes, and so the disease would spread over a large district.

In order to prevent this, a law has been made requiring a notice to be posted beside the door of every house in which there is a communicable disease. In compliance with this law, you will sometimes see on a house a card with the words: "Scarlet Fever", "Small-pox", or "Diphtheria". This card warns people not to enter the house. It directs that the children in the house must not go to day school or Sunday school, and that the grown-up folk belonging to the house must not mingle with others at "bees" or threshings, or in shops, factories, street-cars, or in churches.

You may think this law is a cruel one, because it keeps people from visiting the sick and afflicted; but in reality it is a wise and just one; for it warns people to keep away from disease germs, and it thus helps to stop the spread of disease.

The following diagram shows the result of isolation in a certain number of scarlet fever cases.

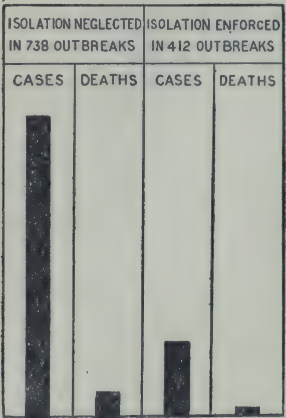


FIGURE 62.—The lengths of the dark columns show how isolation and disinfection have lessened the spread of scarlet fever.

You see at once how very greatly the number of cases decreased when the sick were kept separate from the well.

Now, isolation is not a cruel thing. It is the kindest thing that can be done when you look at the matter from all sides; but isolation of the sick does not keep us from helping them. It forbids us to go into a house where there is an infectious disease; but it does not prevent us from paying a nurse to wait upon the sick, or sending food and clothing to those who are in need of these things.

CHAPTER XXXI

HOW GERMS CAUSE DISEASE

Some of you are no doubt wondering how these germs cause disease; but if you keep your eyes open to many facts that are about you, you will not find it difficult to understand.

Have you ever noticed dark blotches on the skin of an apple? If you have, you have seen a disease that

is caused by a plant closely related to bacteria. We cannot say that the apple tree is sick, or that it has a fever, or suffers pain; but we can truthfully say that the apples are diseased. Such fruit will not keep as long as that which is free from blotches. It soon begins to decay just where the blotches are. Every fruit grower knows this very well, and in the spring he takes great pains to spray his trees with a mixture of chemicals that will kill the microbes which cause this disease.

Or take another example. Have you ever seen a tree, part of which was alive and part dead? A boy may have chopped off some of the bark from the tree and exposed the soft, sappy wood underneath. Then something like this took place. Microbes from the air fell upon this tender, moist wood, began to grow, and in the very act of growing caused the death of the underlying wood. It does not always follow, of course, that the whole tree dies. Only that part may die which is close to where the cut was made.

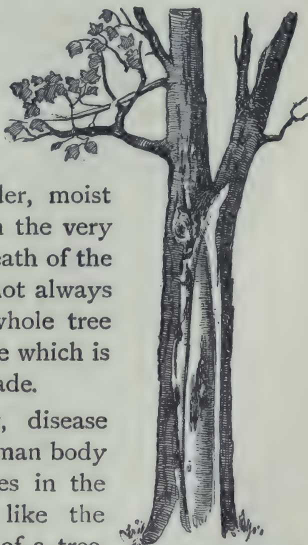


FIGURE 63.—Process of healing in a wounded tree.

In much the same way, disease germs, in growing on the human body or inside of it, make changes in the flesh and blood that are like the changes in the rotting wood of a tree. In growing, the germs form poisons called "toxins". Some of the flesh decays, and the blood becomes poisoned just where the

bacteria are growing. Then this poisoned blood circulates all through the body, the person becomes hot and is said to be in a fever.

Moreover, if the changes in the flesh and blood are very great, the person has much pain and fever and becomes unable to eat. Then he grows very ill and weak, and at length dies, unless the disease is cured.

You will now be able to understand what is meant by "catching" a disease. Of course, you cannot really catch any disease. What happens is this: disease germs enter the body either directly from a sick person, or indirectly from food, or water, or from the thousand and one other objects which you may happen to touch or handle. Sometimes they enter the body by a scratch, cut, or pimple. The germs are said to "infect" the body, and the pain, swelling, redness, and fever are the signs that the germs are increasing in number and destroying the tissues of the body.

The diseases which are spread in this way are said to be "communicable" diseases. A few years ago we used to speak of some diseases as infectious and others as contagious. The better term is communicable. "Contagious" means that germs are conveyed from one person to another in one special way, namely, by touch or contact; but all contagious diseases are also infectious; that is, all are probably caused by microbes.

The old idea that disease germs spring from filth must be completely abandoned. We know of no case in which disease has been caused by filth itself. It is quite true that filth of various kinds may be the food or soil upon which disease germs grow; but the germs

themselves, whose presence in the filth causes the disease, must first have been planted there from somewhere else.

Wheat grows on a field only when wheat has been sown on the field; and, in the same way, disease germs of any kind grow on a human being or in a human being only when the germs of that kind have been sown there. Thus scarlet fever germs spring from scarlet fever germs and from no other source, and the germs of typhoid fever from the germs of typhoid fever and from no other source.

There is no mystery about the spread of many diseases, if you will but remember that they are caused by the growth of minute parasitic plants or animals whose invisible seeds must come from some parent source. As Florence Nightingale long ago expressed it, the germs of each communicable disease reproduce themselves just as naturally and certainly as if they were cats or dogs.

How is it that some people catch communicable diseases, while others do not? It never happens that every person in a city or country district takes consumption or typhoid fever or influenza. Some always escape. Why?

We shall return to this subject later, but for the present it will be enough to say that the germs of certain diseases will not grow readily in some people, while they do grow readily in others. Some people are born with bodies vigorous enough to kill the invisible seeds which alight upon them; others are not so born. Then again, people are very liable to catch infection

when they are run down in health; whereas, when they are vigorous, they may suffer no harm from disease germs.

Three things, therefore, are necessary before we can catch a communicable disease. First, there must be the germ; secondly, this germ must enter the body in some way; and thirdly, we must be in such a condition as to take the disease, either because we are naturally liable to it or because we are in a state of poor health.

The resistance of the body to the infectious diseases is lowered by alcohol. It facilitates the entrance into the body of the germs of consumption, pneumonia, blood poisoning, and other diseases. It impedes the action of the white corpuscles, which are the body's army of defence and makes them slow to move against these enemies. And so it happens that a chill or some slight injury to a part of the body, which would have no ill effect upon a vigorous man or woman, sometimes leads to a fatal ending in a habitual user of alcohol.

CHAPTER XXXII

HOW TO AVOID INFECTION

We can avoid infection from disease germs in three ways: (1) by keeping away from the source of infection, that is, away from persons who are sick with an infectious disease, or who carry germs; (2) by killing the germs by means of boiling water or by the use of chemicals known as disinfectants; and (3) by taking

care to keep our health up to a high standard of perfection.

Professor Lister of Edinburgh was the first surgeon in the world to make use of Pasteur's idea that the air contains the germs of disease. After reading about Pasteur's work and that of men engaged in similar experiments, it occurred to Lister that if he could only keep the germs in the air out of surgical wounds they would heal up much more quickly than was usually the case. He, therefore, began to perform all of his surgical operations under a spray of weak carbolic acid, so that any germ that might fall from the air into the wound would be killed. The result was that in his hospital practice, even in the midst of surroundings that were reeking with the germs of blood-poison, erysipelas, and gangrene, he was able to keep his patients free from these terrible scourges.

FIGURE 64.—Surgeon in uniform. The mask and the gloves prevent germs from being transferred to the patient.

To-day surgeons do not perform any difficult or dangerous operation in the wards of a general hospital. The risks are too great. Nor do they use Lister's method of spraying wounds, though they use his principle

of protecting the wound from germs. They have what is known as an operating-room, and this room, as well as the instruments, the nurse and her clothing, and all the linen or cotton dressings, are kept so clean that to-day it is a rare thing for the germs of any disease to find lodgment in a wound.

The surgeon pays very little attention to the air of a clean, well-ventilated room in which he is about to operate. He puts on overalls of clean sterilized cotton or linen, ties several layers of sterilized gauze over his mouth, nose, and head, and proceeds with his work. His chief concern is to guard against infection from his instruments and from himself or his assistants.

A few years ago, it was believed necessary to have separate rooms in a hospital in which to treat the different communicable diseases; to-day we have hospitals in both France and Britain in which patients with small-pox, diphtheria, measles, scarlet fever, erysipelas, etc., are all treated in the same room.

When it does happen that a disease spreads from one patient to another in such hospitals, it is believed that the nurses or the patients themselves have not been careful to avoid what is known as contact infection, that is, they have either touched each other, or have used some article or food in common. In other words, the infection has spread—not through the air, but through the carelessness of nurses, patients, or doctors. The germs of the communicable diseases are not conveyed in the air from room to room, nor even from bed to bed in the same room, if proper precautions are taken. (See page 152).

Contagious disease hospitals, therefore, may be located in even a thickly inhabited part of a city, without danger of spreading disease through the air to the general public.

FIGURE 65. — End of a lead-pencil bitten by different pupils.

Keeping in mind the fact that disease germs may be transferred on almost everything we touch or handle, it follows that there are some practices, common in many schools and homes, which should be at once stopped. For example, the practice of having a number of pens and lead-pencils kept in a box and passed round to pupils from day to day, is wrong; because some pupils have the habit of holding these articles in the mouth, and they may be the "carriers" of such diseases as diphtheria, measles, scarlet fever, mumps, whooping-cough, pneumonia, influenza, "common cold", tuberculosis, or cerebrospinal fever. The next time the pencils are passed round the class, other pupils in turn place them in their mouths, and the result is that disease is sometimes spread from pupil to pupil. Then, too, the common drinking cup should be banished. Each child should have his own cup, hanging ready for use below his desk, and, when he is thirsty, he should go to a water pail fitted with a cover and tap, and draw the water directly into his cup; or, if there is a well upon the school grounds, he should draw the water from the pump.

Wash-basins and towels are provided in many schools for the use of the pupils, but this is an objectionable

practice; for cases are well known in which horrible diseases, particularly of the skin, have spread from one

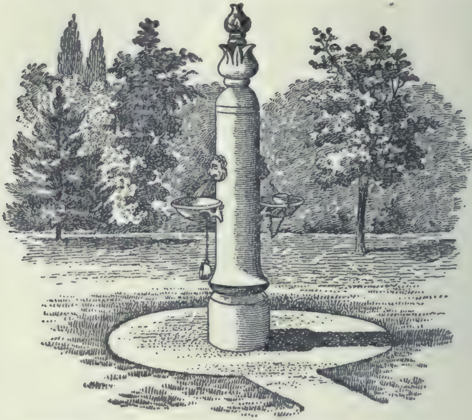


FIGURE 66.—Drinking cups at a public fountain are sometimes a means of spreading disease, and should not be used.

diseased person to others through the use of a common towel. It is much better, therefore, to err on the side of safety, and to avoid using towels, combs, brushes, and pencils, which have been used by a number of people.

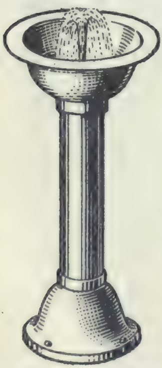


FIGURE 67.—A safe drinking fountain. No drinking cup is used.

You may learn how thoughtful men and women look at this matter if you visit the wash-room of a first-class hotel or of a Pullman car. There you will find that each guest or passenger is provided with a separate towel and a separate package of soap. Each uses his own comb and brush.

In order to avoid communicable diseases, it is a good rule, when you are travelling, to stay only at those hotels which are kept scrupulously clean. This will cost you a little more money, but it may be much the cheaper plan in the end; because, if by staying at an uncleanly hotel you should happen to contract diphtheria or scarlet fever or consumption, or if you should carry the invisible seeds of one of these diseases to some one at home, it would in the end cost you or your relatives vastly more money and would entail greater risks than if you had stayed at a first-class hotel.

Then again, when you are away from home, you should be careful to send your washing out to be done in a clean house or laundry. As a rule, it is safer to have washing done in a laundry than in a private house. The manager of a laundry is usually careful to disinfect all clothing that is sent to him; that is, he soaks the clothing in a solution of some chemical such as carbolic acid or bichloride of mercury. He leaves the clothing for a considerable time in these chemicals, in order to make certain that all disease germs have been killed. Or, instead of disinfecting the clothes by means of chemicals, he may use boiling-hot water or steam. When clothing has been well boiled, there is little danger of any of the work-people in the laundry catching any disease from it.

Nor, on the other hand, is there any danger of disease spreading from the laundry to private houses, except possibly when some of the workers in the laundry bring disease germs from their homes and handle the clothes after they have been dried and ironed.

As regards washing that is done in our own homes, no special care need be taken with it, if there is no

communicable disease among members of the family. But, if any one in a family is suffering from a communicable disease, then the greatest care should be taken, not merely in washing the clothing, but also in handling it.

You must never forget that liquid discharges of every kind, whether from the eyes, ears, nose, mouth, throat, lungs, intestines, kidneys, or skin of persons suffering from communicable diseases, may contain the germs of these diseases and are, therefore, dangerous. Some discharges are dangerous when moist and dangerous also after they become dry; because, when they are deposited upon the floor, upon handkerchiefs, bed-clothes, or wearing apparel, they dry up, and the germs in the dried discharges are very easily scattered through the air and give the disease to other members of the family. Of course, disease germs are generally frail things and do not live long in dry air nor in sunshine; but even so, it is always better to be careful about handling infected articles, whether wet or dry.

In order to avoid communicable diseases, it is important that you take such good care of your health that you will always be strong and fit for your work. When you are in robust health, you will escape a disease like consumption, which you may contract when you are run down in health. For you must never forget that your bodies—both inside and outside—are the soil on which disease germs grow.

If the juices of your bodies are in a healthy state, they will generally kill disease germs, and you will escape communicable diseases in this way. What are

these juices you may ask? They are the fluids which form naturally on the lining of the nose, mouth, throat, windpipe, stomach, and bowels. If the germs are not killed by these juices and happen to get into the blood, then the blood or other fluids in the body, if they are well-nourished and healthy, may do the killing.

But, if you are run down in health through poor food or overwork or worry or lack of rest and sleep or the constant use of alcohol, then every part of your body—juices, blood, flesh, and all, falls into a bad state and loses its power of killing disease germs. People in this run-down state contract various diseases which people who are in good health escape.

We may sum up, then, by saying that the first great rule in avoiding communicable diseases is to avoid direct contact with infected persons, or indirect contact with them through food or articles which they have mouthed or handled. We must be clean ourselves and keep our surroundings clean. And the second great rule is to keep the health up to a high standard. Stop working altogether when you are feeling "under the weather" and unfit to do your daily work. Rest and good food will make you strong and robust in a few days or weeks, and you can return to your work again, feeling that, excepting in case of accident, you will escape all communicable diseases if you should happen to be exposed to them. But you should never neglect to take ordinary precautions to prevent the transmission of disease germs from others to yourself and also from yourself to others.

CHAPTER XXXIII

CLASSIFICATION OF COMMUNICABLE DISEASES

It has been already stated that there are a number of diseases known to be caused by germs which grow either in the human body or on its surface. No one, of course, would expect school children to study all these diseases so as to be able to distinguish them from one another. In fact, some of them are puzzling even to a doctor. But it is desirable that school children should study how these diseases are spread, so as to be able to guard against their transference from person to person in a home or in the community.

Young people should bear in mind that in nine cases out of ten infection spreads directly or indirectly from a sick person to a well one. Accordingly, whenever you meet a case of a communicable disease, you should ask yourselves these questions: From what part of a sick man's body do the germs spread? Do they come from the skin or from pimples on the skin? Do they come from the nose or mouth? Do they come from discharges from the alimentary canal or from the urinary tract? Or, may the germs be in the blood of one sick person and be transferred to the blood of a well person by some biting insect like a stable-fly, a mosquito, a bed-bug, flea, or tick? Might not the sharp claws of a cat which had first scratched a diseased animal or man and afterwards scratched a healthy child, transfer the germs from one to the other? Would it be possible for germs that pass out with the excreta from the intestines or from the kidneys to get into drinking water

or milk and pass thence into the stomach of a well person and give him some particular disease?

The greatest medical men in the world have tried to answer these questions, and, as a result of their studies, it is now possible to give a rough classification of the communicable diseases, based upon the manner in which they are spread. In the following classification you will observe that some of the diseases are mentioned in two classes, and to this extent the classification is faulty, but it is the best that can be given to beginners in the study of hygiene.

It is most important for children and parents to remember that there are now special remedies or treatment for a number of the communicable diseases.

Typhoid and paratyphoid vaccine, small-pox vaccine, whooping-cough vaccine, anti-tetanic serum, diphtheria antitoxin, and the rabies (Pasteur) treatment are now given to the public of Ontario free of charge by the Provincial Board of Health.

All applications for these should be made through the Local Board of Health and the Medical Officer of Health.

Class I.—Diseases which are spread largely by means of discharges from the mouth and nose: tuberculosis, pneumonia, called also inflammation of the lungs, diphtheria, influenza, called also *la grippe*, "common colds", cerebro-spinal meningitis, small-pox, and children's diseases—scarlet fever, measles, whooping-cough, chicken-pox, and mumps. They are also spoken of as air-borne diseases, because they are spread from the fine drops of spray which issue from the mouth and the nose in coughing, sneezing, speaking, or singing. It must be

observed, however, that the term air-borne is not strictly correct if it means that separate germs are carried from person to person through ordinary air. But, if it means that the germs are carried through the air collectively in the fine droplets of saliva or sputa, then there is no objection to its use.

Class II.—Diseases which are spread by means of discharges from the intestinal tract: typhoid fever, cholera, and dysentery.

Class III.—Diseases which are spread by the bite of insects: malaria, yellow fever, plague, typhus fever (ship fever), relapsing fever, Texas fever, Rocky Mountain spotted fever, trench fever, etc., including a number which occur only in hot countries.

Class IV.—A miscellaneous list of diseases which cannot be included in the other four classes: infantile paralysis, glanders, anthrax, foot and mouth disease, Malta fever, leprosy, rabies (from the bite of a mad dog or fox), tetanus (lock-jaw).

If you will learn how one or two of the diseases in each of these four classes are spread, the knowledge you will thus acquire will enable you to understand how other diseases are spread and how their distribution in a community may be prevented.

And first let us begin with tuberculosis, because this disease causes more deaths than any other one in Canada. Next in order come pneumonia and cancer.

Nearly eight per cent. of all deaths are caused by tuberculosis, and that, too, during the most useful period of human life—sixteen to sixty years of age. It is more prevalent among the poor than among the well-to-do;

because poverty means worry, hard work, bad housing, lack of adequate food, and insufficient clothing in winter—which all render the poor more liable to the disease.

The germ which causes the disease in man is known as the tubercle bacillus; but as a matter of fact there are at least four different kinds of this bacillus: one found in man; one in the cow; one in birds; and one in fish. In man the disease is known as human tuberculosis, whereas in the cow it is known as bovine tuberculosis.

Probably from twenty to thirty per cent. of the tuberculosis found among children is of the bovine kind and arises from the use of the uncooked milk of tuberculous cows. The bacilli find entrance to the child's body either by the tonsils or by the small intestine.

FIGURE 68.—The tubercle bacilli are represented by the very fine lines. *P.C.*, represent pus cells.

When cows have suffered for some time from this disease, it spreads to the udder, and the germs are found in the milk. Whether the flesh of tuberculous cows will give human beings consumption or not is a matter in dispute; but we do know that the milk from such cows produces bovine tuberculosis in weak and sickly people and especially in infants.

It has been discovered that sometimes half the cows which supply milk to a town or city are tuberculous, but as a rule, not more than five per cent. of the cows in Canada or the United States are thus affected. In some places large numbers of such animals have been slaughtered in order to protect the public health; but in Canada the government has made provision for compensation when such a procedure is necessary, thus reducing in large measure the heavy loss which would otherwise fall upon the owners.

The conviction is growing every day that, if we would decrease the spread of this disease among cattle, we must see to it that the stables in which they live are properly constructed. Cow stables should be large enough in proportion to the number of the herd to give every animal ample air space and plenty of light; the food should be plentiful and of the best quality; the building should be kept scrupulously clean; and when an animal is losing flesh, coughing frequently, or giving other signs of being unwell, it should be isolated from the rest of the herd.

Until such times as farmers erect better stables, keep them cleaner, feed their cows better, and see that the animals get plenty of sunshine and fresh air both winter and summer, just so long will their herds suffer from bovine consumption and be a menace to people who drink the milk.

If the tubercle bacillus lodges in the lungs, it produces pulmonary or lung, tuberculosis. Less frequently it enters the stomach with the food and produces intestinal tuberculosis. Still less frequently it enters the body

through a scratch or pimple, and gives rise to a tuberculous "sore" on the skin. If, however, the bacilli are carried in the blood to bones, brain, glands, or muscles, then the disease is said to become generalized, that is, it spreads throughout the whole body.

How the disease spreads has already been indicated. The dead portions of the lungs which are coughed up from time to time and known as "sputa", are a fruitful source of infection.

Saliva is the healthy juice which flows into the mouth from the salivary glands. Sputum, on the other hand, means the mixture of saliva and dead matter from the throat or lungs which is discharged after a single cough or an attack of coughing. Sputa is the plural of sputum and signifies the diseased material that is coughed up during a period of time. Practically all physicians agree that tuberculosis spreads from one human being to another by tuberculous sputum, and that, to a less extent, it spreads from cows to human beings through the drinking of tuberculous milk. The evidence at hand supports the view that in some cases the germs enter the body with the inspired air, and in other cases they enter by the digestive tract.

When tuberculous sputum dries upon a floor or side-walk and becomes ground into powder by the trampling of many feet, thousands of the tiny bacilli float as fine dust in the air. For this reason you will see notices posted up forbidding people to spit upon the floors of street-cars or public buildings or upon the side-walks.

Now, while this is no doubt one way in which the disease is spread, it is not by any means the only way.

A consumptive mother may give the disease to her child by kissing it. Or a consumptive person may cough over the food at the family table and give the disease to others; for, in coughing, it often happens that very fine particles of froth or spittle are ejected from the mouth. These may contain the germs of consumption, and, falling upon the food, they may enter the stomach of another person and give him the disease.

CHAPTER XXXIV

TUBERCULOSIS AND THE HOME

Tuberculosis is largely confined to human dwellings and is, therefore, spoken of as a house disease.

As the disease is generally transferred from person to person through direct contact, there are two effectual means of preventing its spread. One is to kill, if possible, every germ that leaves the body of a consumptive, and the other way is to keep ourselves well and strong. The germ is dangerous only to persons who are in a run down condition of health. A man or a woman, a boy or a girl, is immune while strong and vigorous. But when one is suffering from a severe cold, or when one is just recovering from an attack of la grippe, measles, scarlet fever, or any other disease, then is the time to be on one's guard. Drunkenness, overwork, worry, too little rest or sleep, too little food, ill-digested food, a dusty atmosphere, bad ventilation, foul odours from sewage, —anything and everything in fact which will lower the vitality of the body, renders us liable to take consumption when we are exposed to the germs.

Treatment in the home being unavoidable, what rules should be followed so as to prevent the disease spreading from one member of a family to another?

Keeping in mind the fact that the usual source of infection is small particles of sputum ejected in coughing and sneezing, boys and girls will easily understand the reasons for the following rules:

FIGURE 69.—Second story sleeping porch, in which the windows are movable and are kept open on the lee side, and closed on the windy side during the night.

SPUTUM

1. Consumptives should deposit all sputum in a spittoon containing a strong germicide, such as a five per cent. solution of carbolic acid in water.

2. If sputum is deposited in a handkerchief, it should not be allowed to dry, but the handkerchief should be boiled for half-an-hour and then washed. Instead of a handkerchief a patient may use a clean cloth, which is afterwards burnt.

3. A consumptive, when out of his room, should use a pocket spittoon, and this should be regularly disinfected.

4. He should always, when coughing, hold a clean cloth over his mouth. This cloth should afterwards be burned.

5. He should not swallow his sputum, because by doing so he may contract consumption of the intestines.

6. The greatest possible care should be taken to prevent sputum from getting upon the hands, face, clothing, or bed-clothes of the patient himself or of others who may wait upon him. If this should happen, the hands and the face should be thoroughly cleansed and the articles of clothing carefully disinfected.

Articles Handled

1. All dishes, knives and forks, spoons, etc., used or handled by a consumptive patient should be kept exclusively for his own use. Each time after being used they should be washed in boiling water to kill any germs that may adhere to them.

2. Consumptives should not be assigned to any situation or carry on any occupation in which they would be required to handle food or clothing belonging to other people.

3. The wearing apparel of consumptives should be disinfected if it is to be used by others.

Rooms

1 The rooms occupied by consumptives should not have carpets or contain anything which will harbour dust particles. Rugs and curtains should never be shaken, beaten, or swept, except in the open air and after being exposed to sunlight for a few hours. Shaking or beating rugs and curtains will scatter the germs through the air, and thus become a means of spreading the disease. Bed-clothes should be frequently exposed to sunlight.

2. Damp cloths should be used in dusting floors, woodwork, furniture, windows, and walls, and these cloths should be afterwards well boiled.

3. Bedroom windows should be open night and day, summer and winter.

4. A consumptive should not sleep in the same bed with another person. If possible, each patient should have a room to himself.

5. When a consumptive vacates a room, it should be thoroughly disinfected. Its wall-paper, if any, should be removed, and then the floors, woodwork, windows, walls, and ceiling should be thoroughly washed with a disinfecting solution or sterilized with formaldehyde vapour. Afterwards, as much air and sunlight as possible should be admitted.

Conduct

1. Consumptives should not kiss other people.

2. They should spend most of the time in the open air.

3. In the early stages of the disease they may, with a physician's advice, occupy themselves in some light labour for a short time each day.

4. Above all, consumptives should avoid all medicines that are advertised as sure cures for consumption. None of these medicines are of any value in the cure of consumption.

If a consumptive carefully observes all these rules relating to sputum, articles handled, and care of room, it is quite possible for him to live in a home without communicating the disease to others.

While the observance of this routine, together with sleeping outside, both summer and winter, will greatly aid in recovery, there are several other things about which a patient needs the special instruction of a physician, and those who may have the disease will do well to consult the family doctor from time to time as may seem necessary.

CHAPTER XXXV

DISEASES OF CLASS I—DIPHTHERIA

The diphtheria bacillus usually enters the nose or the mouth, grows upon the mucous membrane of the nose and the throat, and is discharged from these same parts in sputa. If the mucous membrane is irritated by any cause, such as by colds, sore throat, adenoids, or excessive dust, the bacillus finds soil that is all the more suitable for growth.

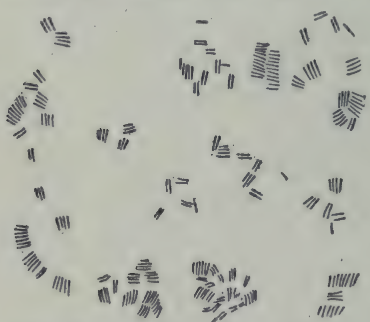


FIGURE 70.—The fine lines represent groups of separate diphtheria bacilli.

The transference may occur in kissing, but more generally it is conveyed directly through droplet infection in speaking, sneezing, coughing, or singing. It cannot be said to be air-borne excepting through a few feet, because the germs are frail and die easily in dry air and sunshine. Indirectly the germs may be transferred by toys, pencils, food, fingers, jack-knives, handkerchiefs, or other common objects.

Carriers make up about one per cent. of the population and play a large part in spreading infection. So too do convalescents and mild and missed cases. It is usually through missed cases that the disease is kept alive in the community. In a household in which perhaps only one individual has taken the disease, it is not uncommon to find others who are carriers, especially where no adequate precautions have been taken to isolate the sick. Microscopical examination of discharges from the throats of children in infected schools and of attendants in hospitals shows from eight to thirty per cent. as carrying the disease.

The germs grow well in milk and that, too, without destroying either its flavour or its appearance. The germs may come from one who has been sick and has milked the cows. Or, of course, they may come from one who nurses the sick and handles the milk at either the farm, the dairy, or the shop where the milk is sold. If the milk is peddled from house to house along different streets, the diphtheria cases always appear in the houses at which the milk has been delivered. Those to take the disease first are the first to drink the raw or uncooked milk.

The most important step to be taken in controlling an outbreak of diphtheria is to isolate not only the sick, but also the carriers. This is easily done in institutions like jails, asylums, hospitals, or residential schools, but it is a more difficult procedure when the outbreak occurs among the community at large. Schools need not be closed in even a serious epidemic, if a physician or skilled nurse visits the school every morning and excludes all children whose nose and throat show signs of the oncoming of the disease.

If you will review the chapter on how germs cause disease, you will see that, in growing on or in the human body, they produce poisons called toxins. It is the absorption into the body of the toxin of diphtheria which causes the serious symptoms. Now, whenever this toxin enters the body, the blood starts to make an antitoxin or antidote to the poison. If the blood has enough antitoxin in it, or can make enough antitoxin to overcome the toxin, the patient soon gets well, if not, the patient may die. So you see the manufacture of diphtheria antitoxin by the blood is one of its important functions.

Supposing the blood of a patient does not contain sufficient antitoxin to overcome the toxin, what is to be done? A wonderful thing has been done. In order to make sufficient antitoxin to save human life, the toxin of the diphtheria bacillus has been injected into a horse, and, as a result, the horse's blood has manufactured comparatively large quantities of antitoxin. Subsequently, when some of the horse's blood has been withdrawn and allowed to stand until it clots, the serum or liquid which oozes out from the clot has been found, when injected into a patient's body, to be a perfect remedy for diphtheria. In other words, when the scanty quantity of antitoxin in the human body is increased by antitoxin from horse's blood, the disease is cured.

Diphtheria antitoxin was the first antitoxin to be discovered, and is still the most efficient one known, but medical men in different parts of the world are trying to discover other antitoxins which will kill the toxins of other infectious diseases. Thus far they have been successful in finding antitoxins for tetanus (lock-jaw) and for cerebro-spinal fever.

Since 1894 the deaths from diphtheria have fallen off greatly because of the use of antitoxin; but, in order that this remedy may be effective, a doctor should be called in and antitoxin used within the first twenty-four hours of the onset of the disease. This cannot be over emphasized. Hundreds of lives can be saved if the doctor is called in at once in every case of a bad sore throat.

Practically all the deaths from diphtheria to-day are due to delay in calling the doctor and receiving antitoxin. Antitoxin is distributed free by the Provincial Government.

CHAPTER XXXVI

DISEASES OF CLASS I—PNEUMONIA, MEASLES, SCARLET FEVER, WHOOPING-COUGH

Pneumonia occurs in all countries, among all people, and at all ages. It is due to a small spherical germ called a coccus. (See Figure 71.) The special coccus of pneumonia is known as a pneumococcus. The lungs are the special part of the body in which it grows, but it is found in the blood also.

FIGURE 71.—The smallest dots represent the pneumonia cocci. *P.C.* denotes pus cells.

While the colder months of the year increase its frequency and fatality, especially among the very young and the aged, a second reason

for its frequent occurrence is found in crowding—whether in homes, jails, orphanages, or hospitals, because in these places contact infection is easy.

One attack of pneumonia does not protect from a second; rather is the reverse the case. The same remark may be made regarding common colds and influenza. A second attack of any of these diseases diminishes the resistance of the body, and, consequently, a person may have pneumonia a second time, or may catch a succession of colds. Dissipation, loss of sleep, worry, poor or scanty food, lack of exercise, excesses of all kinds, and badly ventilated houses all tend to increase the number of cases of pneumonia, colds, and influenza, whenever exposure to the germs of these diseases occurs.

"Colds" are caught, not from draughts, nor from sudden changes of temperature, nor chilling of the body, but from other persons who have colds. Arctic explorers never catch cold in the north, but do so as soon as they return south and become infected by contact with those who carry the germs of cold in the nose or the throat.

Colds occur as epidemics and spread, not merely from member to member of a household, but through schools, shops, and factories.

We can do much to make ourselves hardy and keep ourselves free from colds by taking a cold bath every morning, summer and winter, or at least by washing the face, hands, neck, and chest with cold water, and rubbing vigorously afterwards with a coarse towel. But a cold bath should never be taken in a cold bath-room. Nor, if one is suffering from a cold, should a cold bath be taken. Chilling oneself should always be

avoided. Even the chilling of the hands or feet may make a cold grow worse.

The benefit of a cold bath includes something more than mere cleanliness of the skin. It stirs up the body to produce more heat, in order to make good the loss of heat which occurs when one is in the cold water. Exposure of the body to dry, cold air as in winter has the same effect as that of a cold bath. In both cases the loss of heat is at once followed by the generation of more heat by the muscles and the glands of the body. This generation of heat is followed by an increased demand for food and for oxygen, by an increased heart-beat, and by better circulation of the blood. So that the effect of cold applied to the skin, whether in the form of cold water or cold, dry air, is very beneficial, especially to healthy people.

The prevention of common colds would go far toward preventing the spread of nearly all the more serious diseases belonging to this class. If persons suffering from colds would only remain in bed for three days, they would recover more quickly and would, at the same time, prevent the infection from spreading to others in the family.

The germ of measles has not as yet been identified under the microscope. We infer, however, that the disease is caused by a germ, because the mode of transference, the course of the disease, and its control as an epidemic, all resemble other infections of a similar kind.

Transference occurs most frequently during the early stages. One attack usually protects from a second, but not always. Carriers are not known to occur. Fumigation of houses by formaldehyde may be practised, but is

not necessary, if sunshine, fresh air, and cleanliness are allowed to do their work. All bedding, towels, handkerchiefs, and other articles which have been used by the patient should be boiled or otherwise disinfected.

Scarlet fever is about as communicable as diphtheria and less so than small-pox or measles. Contrary to general belief, the disease is not spread from the peeling skin, but is easily transmitted when the rash is out and there are discharges from the nose, ear, and throat. "Walking" cases occur; frequently the only evidence of the disease is a sore throat.

Milk may be the means of spreading disease through a village, town, or city, if the germs of disease have been sown in it. No one knows how many different kinds of disease may thus be carried from house to house in milk; but we do know that consumption, typhoid fever, scarlet fever, diphtheria, and diarrhoea are spread in this way. Of course, these diseases are not thus spread over a country district, because milk is not peddled from one farmhouse to another; but every doctor knows how disease may be spread from house to house along the route of a city milkman.

Whooping-cough germs multiply in the windpipe and bronchial tubes and are discharged thence in droplets which spread the disease. It is most infectious during the early stages, but the germs continue to be discharged for six weeks after apparent recovery. Whether dogs and cats are agents in the transference of this disease is doubtful.

The death-rate from whooping-cough is high among children under five years of age, because the disease is frequently followed by bronchitis or pneumonia.

CHAPTER XXXVII

DISEASES OF CLASS I—SMALL-POX

Up to the time that Dr. Jenner proved the efficacy of vaccination in 1796, small-pox had been a terrible scourge to mankind. It is estimated that 60,000,000 of people died of this disease in Europe alone in the eighteenth century. A French physician in 1754, said that "every tenth death was due to small-pox, and that one-fourth of mankind was either killed by it, or crippled, or disfigured for life".

FIGURE 72.—Dr. Jenner.

One needs to keep facts like these in mind in order to appreciate Jenner's great work. It started from the casual remark of one of his patients: "I cannot take small-pox because I have had cow-pox". The merit of Jenner's work, therefore, was not that he originated the practice of vaccination, but that he converted a vague popular belief into a scientific reality.

Vaccination must be distinguished from inoculation. To vaccinate a person is to give him the disease cow-pox, by scratching under the skin some of the "matter" from the sore on a cow's udder or teats. To inoculate a person is to give him the disease small-pox, by scratching under the skin some of the "matter" from a small-pox sore on a man's body. Jenner performed both operations. He was himself inoculated as a boy—a common practice at the time—because it usually gave the disease

in a less fatal form than when communicated in an epidemic.

Sarah Nelms, a dairymaid, had scratched her hand with a thorn, and in milking her master's cows the wound had become infected with cow-pox. Dr. Jenner transferred some of the "matter" from Sarah Nelm's hand to a skin wound in the arm of James Phipps, a boy of eight years of age. A typical vaccination sore followed, see Figure 73.

FIGURE 73.—Development of vaccination from day to day.
Wound:—1st day, 2nd, 3rd, 4th, 5th, 6th, 7th; 8th to 10th day; 11th to 12th day.

In order to ascertain whether the boy, after feeling so slight an affection of his system from the cow-pox virus, was secure from the disease small-pox, he was inoculated with "matter" from a small-pox sore. Several slight punctures and incisions were made on both arms, and the matter was carefully inserted, but no disease followed. Several months afterwards he was again inoculated with small-pox "matter", but no sensible effect was produced.

A cow may take true small-pox from a human being, but when she does so the germs of small-pox become so altered while multiplying in her body that they can no longer give rise to true small-pox when injected into a man's body. In other words, small-pox can give rise to cow-pox in a cow, but cow-pox cannot give rise to small-pox in a man. Cow-pox can, however,

be transferred from one human being to another, and, as Jenner proved, it protects a person from taking small-pox.

Before the United States took control of the Phillipine Islands, 40,000 of the inhabitants died annually of this disease; but as soon as the Public Health Department enforced vaccination, the disease gradually disappeared from the Islands. Contrast with this the experience of the United States itself, in which one-tenth of the population is unvaccinated, and in which there are 70,000 cases of small-pox annually.

Pasteur discovered a vaccine against a disease of cattle known as anthrax, and another vaccine against rabies (the bite of a mad dog); and, since his time, Dr. Almroth Wright has discovered a vaccine against typhoid fever; but as a matter of fact, vaccination against small-pox is the most efficient one yet discovered.

Vaccination may fail for several reasons, either because the act has not been properly performed, or because the virus has not been good. It is wise, therefore, to have it repeated if necessary three or four times in order to make sure of protection. Inasmuch as the immunity gradually wears off, one should be re-vaccinated after six or seven years, especially if recently exposed to small-pox.

We are ignorant of the precise way in which small-pox germs are carried. They are known to be contained in the sores on the skin and are supposed to be carried and distributed in expired air, but of this we have no proof. Isolation and disinfection are of secondary importance to vaccination in preventing the spread of this disease.

Preventive measures for all the diseases of Class I may be summed up by saying, (1) that you must avoid infection, (2) isolate the sick and disinfect the discharges from nose and mouth, and (3) take care to keep your own health up to a high standard of perfection.

CHAPTER XXXVIII

TYPHOID A DISEASE OF CLASS II

Ugly as the fact is, it is nevertheless true, that every case of typhoid fever means the transfer of germs, either directly or indirectly, from the excreta of one individual to the mouth of another. A typhoid epidemic, therefore, is a reproach to the intelligence and moral sense of a community.

FIGURE 74. The fine lines represent typhoid bacilli.

Needless to say, the typhoid bacilli do not breed in the rubbish heap nor the garbage pail of the back-yard, but they do breed in the intestines of a man who has the disease, so that the patient is the sole source of infection, just as he is the source of all the diseases of Class I.

Normally, typhoid is a disease of warm weather, occurring generally from July to October. Epidemics

of it, however, occur during the autumn, winter, or spring, but always as a result of infected water. It is more prevalent in country districts than in cities, because the city resident is more alert to the importance of a pure water supply. American cities suffer more from typhoid than European, as may be seen from the fact that thirty-three European cities had in 1910 a death-rate of less than six in 100,000; whereas fifty American cities showed a death-rate of twenty-five per 100,000.

From the intestinal tract the bacilli spread throughout the body and appear in the blood, urine, and fæces. It is important to note this discharge in the urine, because, in fighting the spread of the disease, it is necessary to disinfect the urine as well as the fæces.

About one out of every 1,000 of the population is a carrier of the germs, and, from two to three per cent. of those who have had the disease continue to spread the germs during, and for some time after convalescence. It occasionally happens that a carrier continues to pass the germs from his intestines for years after he has recovered from the disease. Women carriers transfer the microbes more frequently than men, because they handle foods more frequently in the capacity of cooks, waitresses, and dairymaids. The problem of detecting the carriers is a difficult one and can only be solved by a skilled physician with all the necessary equipment of a modern health laboratory. Once a carrier is found, it is not necessary that he be quarantined. It will be sufficient to limit his occupations to those in which he will not be required to handle food.

Water-borne typhoid is a common occurrence, though the germs live only about seven days in water. Human fæces, whether from the healthy or the ill, sooner or later pollute surface water and running water alike. The denser the population, the greater the pollution, and the greater the danger of infection. Nevertheless, not more than one-third of the typhoid prevalent in America comes from infected water.

The fact that the germs may live a long time in snow or ice explains how an epidemic may occur in winter or early spring, when there may have been no known case for several months previously. A very serious outbreak of typhoid occurred in Ottawa in January and February, 1911, and doubtless came from the frozen accumulation of excrement from a single case of typhoid, or from a carrier who lived higher up the river than Ottawa city. It is known that, from December 9th, 1910, to January 4th, 1911, the city engineer on nineteen different occasions drew a portion of the water supply from Nepean Bay, which forms part of the city waterfront. It was during this period that a large proportion of the infection apparently occurred. Parts of the drainage into Nepean Bay is from a tiny stream called Cave Creek. The district along this creek is thickly populated, and the water-closets belonging to the various houses are either adjacent to or set over the stream. The creek is therefore an open, elongated cesspool.

Infected milk and milk products, such as butter, ice-cream, fresh cheese, and butter-milk, may all be agents in the spread of typhoid fever. It is also spread from raw oysters and clams grown in sea areas which are infected with typhoid sewage. So, too, eating raw

vegetables, such as celery, lettuce, water-cress, and radishes grown on soil that has been fertilized with human excreta may give rise to a few cases.

Then, too, when the discharges from typhoid patients are emptied, without disinfection, into common privy vaults, there is great danger of flies carrying the germs on their feet from these places to the dining-room, and thus infecting the food. This is believed to have been the way in which most of the typhoid, or "enteric" fever, was spread among the British soldiers in South Africa during the Boer war. The soldiers lived in tents and took their meals outside, and hence it was difficult to cover their food from the flies.

Dust is not likely to transfer the germs, because they are easily killed in dry air and sunshine.

In fighting the spread of typhoid in a city, reliance must be placed upon providing the citizens with a pure water and milk supply. The disinfection of stools, urine, sputum, and other excretions is of the greatest importance. Sputum on handkerchiefs may be boiled or burned. Urine can be disinfected by adding to it a solution of one part of bichloride of mercury in 1,000 parts of water, or a three per cent. solution of carbolic acid, and allowing the mixture to stand for an hour. Stools, especially hard fæces, require special treatment. They should be received in a glass or earthenware vessel, ground into fine particles, mixed with three per cent. bleaching powder or ten per cent. of formalin, and allowed to stand for an hour or two, so that the disinfectant may have ample time to do its work. Similar treatment must be given to towels, sheets, nightgowns, and soiled blankets.

The nurse must be particularly careful. Every time she bathes the patient or cleans his mouth, she should not only disinfect the water, but she should wash her hands first in bichloride solution and afterwards in clean soap and water.

The most effective remedy against the spread of typhoid among large bodies of men, as in the army and navy, is inoculation. The bacilli are heated to 140° F. for about half-an-hour, thus killing them, and they are then injected under the skin. Before this material (vaccine, as it is called) is sent out from the laboratory where it is made, it is carefully tested. The dose varies from 500,000,000 to 1,000,000,000 bacilli and is repeated at an interval of about seven days.

The person does not take typhoid as a result of these injections, but he becomes slightly sick from the toxins which have entered his body with the germs. These toxins cause the formation of defensive substances in his blood, just as in the case of diphtheria, and these defensive substances prevent him from taking the disease.

In the Russo-Japanese war and in the present European war, sanitary regulations have been so faithfully carried out, and the inoculation remedy has been so effective that comparatively few cases of typhoid fever have occurred in either the British, French, German, or American armies.

One attack of typhoid usually renders a person immune for life, but, in order to ensure protection by means of inoculation, the injections must be repeated every two or three years.

CHAPTER XXXIX

CLASS III—INSECT-BORNE DISEASES

For many years past medical men have suspected that some of the communicable diseases are spread from animals to human beings or from one human being to another through the bite of insects, but it was not until 1893 that Smith and Kilborne proved this suspicion to be well founded. These two men demonstrated that Texas fever, known also as bovine malaria, is spread from cattle that are sick to cattle that are well by means of the bite of a cattle tick.

Ticks are not insects. They are close relatives of the spiders, small in size, and live on blood. During their lifetime they pass through four different stages, namely, the egg or embryo, the grub or larva, the nymph, and the adult.

The eggs are laid upon the ground, where they hatch out into grubs or larvæ during warm weather. The grubs may get on to cattle as they lie upon the ground, or they may crawl up grass or shrubs and pass thence to the hair or skin of cattle as they brush past in feeding. Once having reached the skin of cattle, the larvæ gorge themselves with blood, drop to the ground, increase in size, and moult, that is, cast off their skin. The young tick is then known as a nymph. The nymphs also attach themselves to cattle, suck their blood, drop off, moult a second time, and become adults. Each successive generation of ticks goes through the same life-history, egg, larva, nymph, adult.

If a nymph draws blood from a cow that has Texas fever, the germs pass into the intestine of the tick and are distributed thence throughout its body. From the mother tick the germs pass to the egg, thence to the larva, then to the nymph, and, finally, to the daughter tick, so that when an infected mother tick, or its young, bites a well cow, the germs are passed into the blood of the cow and set up the disease, Texas fever.

In order that the germs may continue to live from one generation to another, it is essential that they pass one phase of their life in the blood of cattle and a second and different phase in the body of the tick. Without ticks, therefore, there can be no such disease as Texas fever among cattle, and without cattle the germ of Texas fever could not exist, that is, could not pass through its life-history.

Texas fever does not affect man, but its natural history has been outlined because it was the first disease that was definitely proved to be carried by insects. If you understand how Texas fever is transmitted, you will readily understand how other diseases may be transferred from animal to animal or from animals to human beings by means of the bite of insects.

As an example of how another disease is spread, take the case of malarial fever.

We read of this disease in the times of the ancient Romans. A few miles from the city of Rome there is a large tract of marshy land. Many generations of people living near it have suffered from malarial fever. At certain seasons of the year the disease is very prevalent. The peasants are as much used to the

coming of this disease every year as they are to the coming of cold weather or hot weather. They think the disease is caused by the heat and dampness. A white vapour, they say, oozes out of the soil, and when this is breathed, people take the fever.

But in 1900 a strange thing happened. Two scientific men built a cottage on one of the dampest parts of the tract and lived in it all summer and autumn but they did not catch the fever. They had gone to Italy solely to test the truth or the falsity of an idea which they had about the cause of the disease. Their idea was that the disease was caused by germs getting into the blood, and that when a mosquito sucked such germ-laden blood from a person who had malarial fever and afterwards sucked blood from a well person, the mosquito, in doing so, gave the germs to the well person. In short, they thought that the mosquito was the carrier of malaria germs.

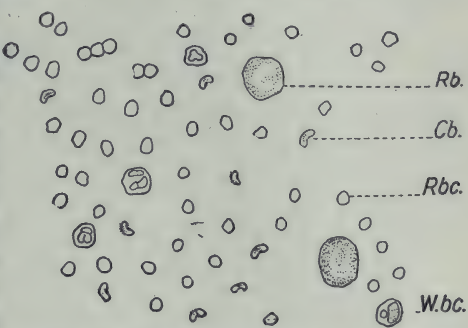


FIGURE 75.—Malarial parasites which grow inside of red blood cells. *Rbc*, red blood cell; *Rb*, ring body; *Cb*, crescent body; *Wbc*, white blood cell with nucleus inside.

Accordingly, they screened their cottage windows and took care not to be bitten by mosquitoes, and they really did escape the disease. But to make sure that their idea was right, they sent to England some mosquitoes which had bitten malarial patients in Italy. When these insects

reached England and were allowed to bite a healthy person, he caught the disease just the same as if he had been in Italy.

As soon as this became known, wise people everywhere began filling up marshes and ponds and thus trying to prevent malaria by killing off the special kind of mosquito which spreads this fever. The kind which spreads it is known as *Anopheles.*

This disease is not caused by bacteria, which as you now know are parasitic plants, but by very tiny animals called sporozoa, which pass part of their life in a mosquito and the other part in the blood of a human being.

There are no fewer than four different kinds of these sporozoa or malarial parasites—all found in man and each one causing its own special kind of malarial fever. All four parasites are transferred by the bite of the *Anopheles*, and the spread of the resulting fevers is prevented by screening the sick from mosquitoes and by killing the larvæ of the mosquitoes.

The remedy for malarial fever is quinine.

CHAPTER XL

CLASS IV—RABIES AND TETANUS

Rabies, known also as hydrophobia, is caused by germs which are transferred in the saliva of a mad or rabid animal to another animal, or to a human being, usually in a bite or scratch. In the order of virulence, the wolf's bite ranks first. After it comes that of the cat, dog, fox, jackal, horse, ass, cow, sheep, and pig. Of

course, none of these animals in biting a person will give him the disease, unless the animal itself has the disease.

Once the germs have found firm lodgment in a person's body, recovery is exceedingly rare. Fortunately, however, the incubation period is somewhat long—about forty days—so that, before the symptoms become pronounced, there is usually time in which to give the patient Pasteur's preventive treatment.

Pasteur found in his experiments that the virus of this disease could be rendered much less virulent for man by passing it through a series of rabbits. Each rabbit was injected with the virus obtained from the brain of the one which had just died of rabies. As the virus passed from animal to animal it gradually became more virulent for rabbits. Each rabbit died in a shorter time than the one which immediately preceded it. Finally, the virus reached a stage in which it would always kill a rabbit with a fixed dose in a certain definite time. Pasteur called this "the fixed virus of rabies". Although the virus had become more virulent for rabbits, it had become weaker for man. Pasteur further found that drying killed the virus which is contained in the spinal cord and brain. When the virus is dried for seven days, it is greatly weakened, but not quite dead. The treatment consists of giving the patient first the dead virus, then the virus which is not quite dead, and finally virus which has been dried for only two days. At least twenty-one injections must be given to insure protection to the person who has been bitten by a mad dog. Hydrophobia cannot be cured when the symptoms have developed, but it can be prevented by this treatment.

It is necessary, then, that you should know what to do when a person is bitten by a dog suspected of being "mad". The wound should be thoroughly cauterized with nitric acid by a doctor. The dog should not be killed. He should be captured and carefully watched for a period of ten days, being properly fed and watered. If the dog is suffering from rabies, he will not eat or drink, will show other symptoms of the disease, and will shortly die from paralysis. If, however, he is perfectly well at the end of this period, there is no danger of the person previously bitten by him developing the disease, because the dog itself was not suffering from the disease. If the dog dies during this period, the head should be removed, carefully packed in a water-tight container with ice, and forwarded to the Laboratories, Provincial Board of Health, Toronto, with all the information that can be supplied regarding the dog's action and the number of persons bitten, if any. A report will be sent to your Medical Officer of Health promptly, and if the report shows that the animal did die of rabies, the person should at once receive the preventive treatment at the Laboratories in Toronto. This treatment is given without charge. If, however, the dog is at once killed, and the head is sent to the Laboratories, it very frequently happens that no definite diagnosis can be made. Hence, if the dog had been kept under observation and shown to be perfectly well, many persons would not have had to take the treatment.

The Pasteur treatment protects the individual, but does not protect the community. The community must protect itself, and this it can do by quarantining and

by muzzling. In England, a few years ago, all dogs were muzzled, and rabies decreased. Then the muzzling law was repealed and was followed by an increased number of cases of rabies. Then the law was again passed and enforced, and rabies was stamped out of the country.

Horses and cattle may be called the "carriers" of the bacilli of tetanus or "lock-jaw". The bacilli which are spore-bearing (see Figure 3) enter the stomach of cattle and horses with their food, and, finding nourishment, warmth, moisture, and other suitable conditions in the intestine of their host, increase greatly in numbers.

They leave the intestine in the fæces, and, hence, nearly all soil frequented by domesticated horses and cattle is polluted with tetanus germs. The bacilli grow in the soil for years. As you might expect, the spores are found in soil, street dust, in fresh vegetables, on clothing, on horse's hair, in hay dust, in barracks, and in hospitals. Fatal cases of tetanus have occurred from wounds made by pins, nails, splinters, and insect bites, the spores in these cases entering either from the soil or clothing, or even from the skin where they lodged before the wound was made.

One of the prominent symptoms (lock-jaw) is the sustained contraction of the jaw muscles so that the mouth cannot be opened. Of course, other muscles also are in tetanic contraction. There is also pain and fever. All these symptoms are due to the absorption of toxins or poisons produced by the growth of the tetanus bacilli in the body. The treatment consists, just as it does in diphtheria, in injecting an antitoxin to neutralize the effects of the toxin.

Just as there is a preventive treatment for rabies, there is a preventive treatment for lock-jaw. To treat a case of lock-jaw, enormous amounts of the antitoxin must be injected, and even then many of the cases are fatal. To prevent development of lock-jaw, when dirt is ground into a wound, as in a street accident, or when the spores are carried deeply into the flesh by a rusty nail or other sharp instrument, only a very small quantity of antitoxin is required. In the early days of the war, cases of lock-jaw were frequent among the wounded men, especially among the soldiers in France and Flanders. The order was then made that every wounded soldier should, at the earliest moment, receive a preventive injection of tetanus antitoxin. Very shortly after this order was put in force, cases of lock-jaw became few in number, and lock-jaw was no longer dreaded. We should remember, then, that when accidents happen in which dirt is carried deeply into a wound, tetanus antitoxin should be injected to prevent this disease. Realizing the necessity for the use of this serum, the Provincial Government distributes a supply to all doctors without charge.

Of the fourth class of diseases one of the most important is known as infantile paralysis, or anterior poliomyelitis. While people of all ages are liable to take it, it generally attacks children under five years of age, and, even when they do not die, about ninety per cent. are left crippled and more or less paralyzed for life.

It is a communicable disease, spreading along the main routes of travel, and spreading also among public gatherings of children. The transfer is apparently by

healthy carriers, or by those who have had the disease in a mild form.

That the disease is on the increase is shown by the fact that from 1880 to 1884 there were only 23 known cases, whereas from 1905 to 1909 there were over 8,000 cases.

The germs are known to occur in the blood, in the intestinal canal, on the mucous membrane of the nose and throat, and especially in the spinal cord of infected persons and animals. Monkeys have taken it, when inoculated with fluid from the spinal cord of a child who died from the disease.

It is possible that the disease is spread from the nose or throat by means of droplet infection, but there is some evidence also that infection is carried from a sick child to a well one by the bite of the stable-fly. As the discharges from the intestine contain the germs, the fæces should always be carefully disinfected.

Until we are sure of its mode of transmission, we shall not know how to guard against its spread. The virus is easily killed by heat and by weak disinfectants.

CHAPTER XLI

PURE AND IMPURE MILK

You will be surprised to learn that it is quite impossible to milk any cow without allowing some bacteria to get into the milk. The milk pail may be made perfectly clean and free from bacteria, the milker may put on garments of spotless white, his hands may be as clean as soap and water will make them, the stable

may be as clean as the cleanest dwelling-house, the cow's body may be washed and groomed until her skin and hair shine like silk; and yet the milk that streams into the pail may contain hundreds of bacteria in every drop.

Where do they come from? After a great deal of work by scientific men, it was discovered that bacteria are always present on the udder and within the teats of a cow. These fall into the pail and continue to multiply very rapidly in the warm milk.

FIGURE 76.—A clean barn-yard.

The first rule for a milkman to follow, if he wishes to have clean, sweet milk, is to have everything about himself, the stable, and the cow scrupulously clean; the next rule is to throw away the first half-cupful of milk that comes from the udder; and the third rule is to keep the milk cool.

The bacteria that are usually found in cow's milk are known as "lactic acid" bacteria, and their effect upon the milk is to turn it sour, especially in hot weather.

In this case the souring is just the fermentation of the carbohydrate (sugar) of the milk, and resembles what occurs in all carbohydrate foodstuffs.

On the other hand, there are proteins in milk which undergo putrefaction under the action of bacteria, and may give rise to poisonous substances. Here the changes resemble those that take place in putrefying meat.

From all this you will see that there are two great difficulties to be overcome in getting pure milk, namely, the difficulty of keeping it clean and the difficulty of keeping it cool.

It is particularly hard to get pure milk in winter, because cows are generally shut up in dirty stables or penned in filthy barn-yards. Dust and dirt surround them on all sides and stick to their hair and udders; filth often becomes incrusted upon their sides; the milkers are slovenly and careless; the cow's udders are not washed and dried; and, as a result, you cannot possibly have clean milk. Milk coming from cows kept in such surroundings smells musty and has an animal taste. Such milk is not healthful, and it is impossible to make wholesome butter or cheese from it.

A good practical test for dirty milk is to filter a pint of it through absorbent cotton. If the cotton is shaped into a disk and placed in the bottom of a glass funnel, warm milk will pass through it quite readily. A stain, varying in colour from yellow to brown or even to black, tells the extent to which dirt and filth have been allowed to mingle with the milk.

If dirt enters the milk from any source—from the milker's hands or clothes, from the milk pail or the stable,

from the cow's udder or teats, from musty or dirty food—then the dirt sows the seeds of bacteria in the milk, and these bacteria in warm weather grow rapidly and soon turn the milk sour, slimy, or musty.

"In order that there may be proper standards for milk which is to be sold, the Provincial Government has given to local municipalities the authority to pass a by-law regulating its production and sale. A model milk act was

FIGURE 77.—A clean cow in tidy surroundings.

framed, and this is now spoken of as The Ontario Milk Act. These regulations of the Act are now being enforced in many towns and cities in Ontario, safeguarding the health of the people in so far as the dangers of infected milk are concerned. The law permits only the sale of milk which contains not less than 3½ parts of butter fat in every hundred parts of milk. It further

provides for the proper pasteurization of all milk sold, unless produced under very special conditions. Milk produced under these special conditions is known as certified milk. These conditions are very exacting, and properly so, if the great safeguard, which pasteurizing the milk furnishes, is to be omitted. The dairy stables must be modern, well ventilated, and kept scrupulously clean. The cows must be free from disease, and, to make sure that they are not suffering from tuberculosis, they must be regularly tested by a competent veterinarian. Any cow which is found to be sick must be at once removed. The cows must be kept well cleaned, and must be specially cleaned before milking. The attendants and milkers must be free from all communicable diseases and must be regularly examined by a doctor. The hands of the milker must be thoroughly washed before milking, and the milk received into properly covered milk pails which have been sterilized before using.

But this is not all. It must be at once cooled, filled into sterile bottles, and kept cool, and should not be over 50° F. when delivered to the customer. A standard also of the maximum number of bacteria which it may contain in summer and in winter is also established. Certified milk must not contain more than 1,000 bacteria in every drop in the summer time, and more than 500 bacteria in every drop in the winter.

You can readily understand why certified milk costs more than twice as much as ordinary milk. It is the very finest milk that is marketed, but, in spite of all the care, it is probably not so safe from danger of spreading disease as pasteurized milk is."

In summer it is not the heat that is the chief cause of the large number of deaths among infants. No doubt

FIGURE 78.—A neat and inexpensive milk-house.

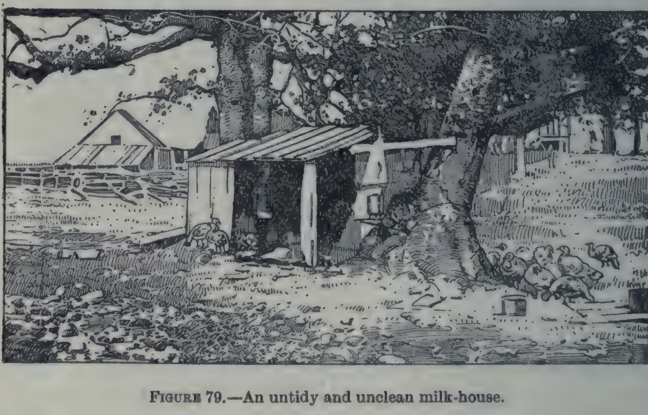


FIGURE 79.—An untidy and unclean milk-house.

heat does make some of them ill, just as it makes grown-up people ill; but the chief cause of the fever and

diarrhœa and deaths among infants in summer is impure milk. This has been proved beyond all doubt, because wherever the diet of babies has been changed to certified milk or pasteurized milk the death-rate has at once fallen.

FIGURE 80.—Cleaning cows before milking.

But bacteria and heat are not the only causes of the high death-rate among babies. Not a few die because of the ignorance or the incapacity of their mothers. Many young mothers have had no training or experience in feeding their infants. Moreover, they are often uncleanly and careless in their habits and allow the milk

to go bad. The consequence is that the little ones are not properly fed.

In order to keep milk from turning sour and to make it keep longer, some milk dealers put chemicals into it, such as boracic acid, salicylic acid, benzoate of soda, peroxide of hydrogen, and formaldehyde. Such milk is known as "adulterated" milk. This practice is forbidden by law in all civilized countries.

How is milk pasteurized? Very simply. It is placed in closed sterilized vessels, that is, in vessels that have been washed with boiling water or steam. It is then heated up to 140° F. for twenty minutes, and immediately afterwards cooled down to 50° F.

FIGURE 81.—A clean milker.

In the home, milk may be pasteurized by placing raw milk in a vessel and heating it in another vessel containing water, until it reaches a temperature of 140° F.

Pasteurizing milk has prevented much sickness, and, as already stated, has saved the lives of thousands of infants. The heating kills the germs of consumption, typhoid fever, scarlet fever, and diarrhœa, without destroying the good qualities of the milk.

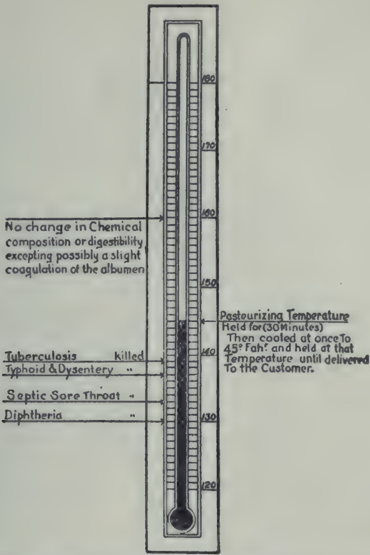


Figure 82.—Thermometer showing points of temperature at which important changes take place in milk.

CHAPTER XLII

PURE AND IMPURE WATER

Water makes up about seventy per cent. of the total weight of the human body. Inasmuch as it is leaving the body all the time—in the breath, by the skin, and by the kidneys, it follows, of course, that we should drink daily at least as much water as we have lost through these different avenues. Most people drink too little water. Every adult should take about two quarts per day in some form—tea, coffee, soup, etc., apart from the

water which is naturally contained in fruits, vegetables, and other foods.

There are manifestly various sources of water supply: surface wells, artesian wells, springs, small streams, or brooks, rivers, and lakes. From which of these can we obtain the purest water?

Rarely can we obtain it from surface wells, for the reason that they are usually dug too close to the barnyard, the kitchen, or the privy vault. As a result, filthy surface water leaks in at the top or passes through the adjacent soil into the water which lies under the ground.

Nor can it always be obtained from springs; because cattle are frequently allowed to stand around these and pollute them with their filth; or surface drainage from higher ground may mingle with the spring and poison it at its source.

So careless are many farmers about the location and surroundings of their wells, that typhoid fever is preeminently a disease of country districts. Every autumn there are thousands of cases of it among the farmers of this continent.

A polluted water with a few typhoid germs in it may not of itself produce an outbreak of typhoid directly, but it may do so through the medium of the milk supply. How this may happen can be very easily explained. If the milk is pure, that is, if it comes from healthy cows, it cannot give typhoid fever to any one. But, if milk cans are washed, as they sometimes are, with water which contains typhoid germs and which has not been sterilized by boiling, then the germs in even the few drops of water

which remain in the can may increase vastly in number in the milk which is afterwards put into the can. The fact is that typhoid germs grow better in warm milk than in anything else. Enormous numbers of them may develop in the milk from a few drops of infected water;

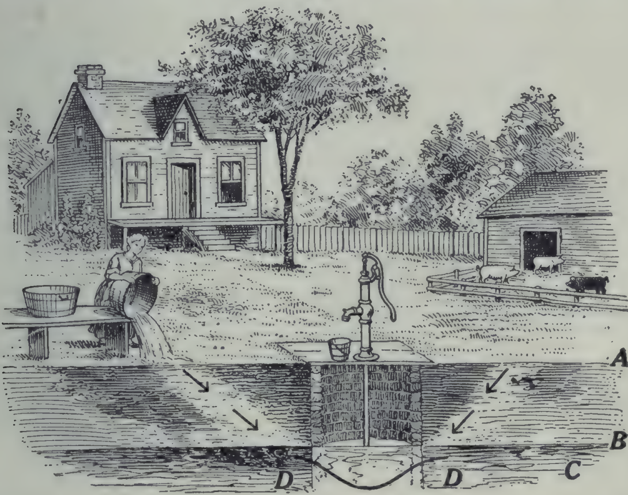


FIGURE 83.—The well, pig-pen, and waste water are too near together. The light shading below the surface shows how the filth from both sides may join the ground water and enter the well, particularly if a large quantity of water be withdrawn by pumping. This would tend to depress the level of the ground water in the immediate vicinity of the well, as indicated at *D D*, and draw polluted water from the surface as shown by the arrows. *A B* vertical section through the ground. *B C* ground water.

and, if this polluted milk is drunk it becomes the means of setting up the disease.

In cities and towns, it is not wise for the householders to have their own wells; because it has been found that when houses are crowded together along the streets, the well-water becomes very impure on account of the filth that gets into it from the surface.

FROM THE POLLUTION INVESTIGATION OF THE INTERNATIONAL JOINT COMMISSION OF 1913

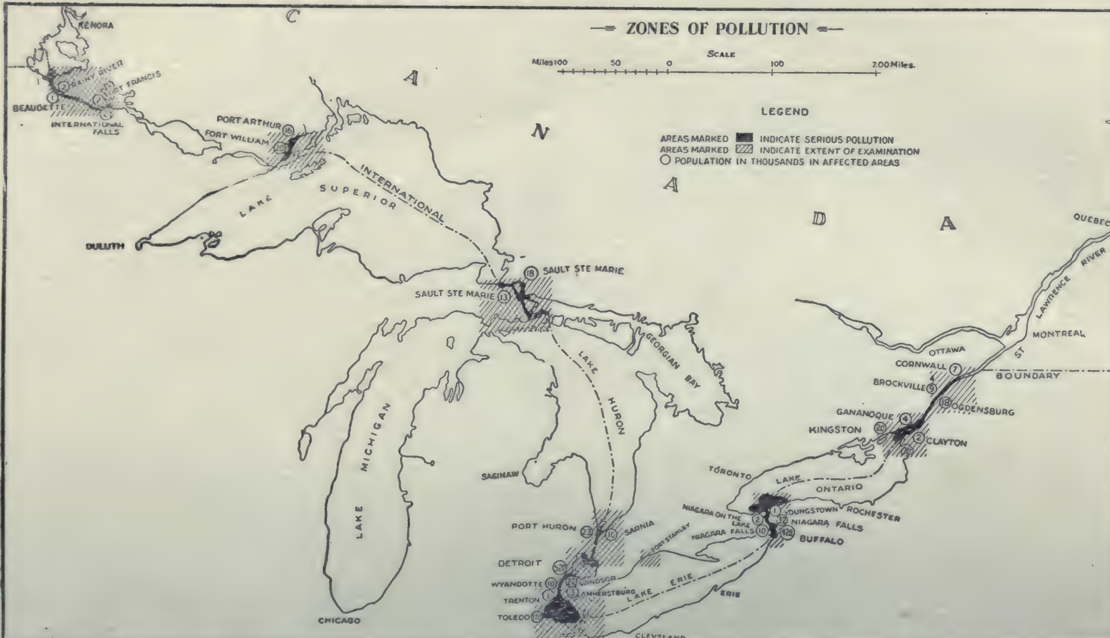


FIGURE 84.—This map represents the boundary waters between Canada and the United States. The dark areas show sewage pollution and, therefore, danger of typhoid fever if the water is used for drinking purposes.

For this reason, in all cities and in most towns, each house is supplied with its drinking-water from underground pipes which bring pure water from lakes at some distance from the town, or from rivers that flow through or beside the town.

Water from rivers, however, is not safe, at any rate for the inhabitants of towns that are located down stream. The St. Lawrence River has been found to be more or less polluted with sewage all the way from Kingston to Montreal. There is a succession of towns and cities situated along its banks which take their drinking-water from the river and pour their sewage into it. The result is that a great amount of sickness occurs periodically in these towns and cities in consequence of the polluted water supply. If we suppose the current to run three miles an hour, and that typhoid germs will survive seven days in water, it is a simple matter to realize that live germs discharged into the St. Lawrence at Kingston, will be alive when they reach Montreal.

In such circumstances it is manifest that each town should either purify its water supply, or treat its sewage so as to protect its own people and not be a menace to its neighbours. It is pretty generally agreed that purification of the water supply is the cheaper of the two processes. It is not possible to treat all the sewage of a city. There is always sewage from some areas of a city district which escapes into the river without undergoing purification. For example, when there is a heavy fall of rain, much of the water, including that from lanes, gardens, and filthy backyards flows directly to the river and thus escapes treatment in purification works. It is quite different with the purification of a water supply. In this case

every gallon of water withdrawn from the river can be passed through filtration beds and purified.

Figure 85.—Showing the river water, sedimentation tank, filtration bed, and filtered water supplied to the town.

Purification of a water supply may be done either by the slow sand filter or by the more rapid mechanical filter. The slow sand filter, called also the English filter bed, consists of about six or seven feet of sand and gravel contained in a tight reservoir and arranged in order somewhat as follows: Three feet of fine sand, three feet of coarse sand, one foot of fine gravel, and one of coarse gravel or broken stone. Each bed occupies an area of about one acre, and of course many acres are required to filter the water for a large city.

Before being passed through the filtration beds, the water is retained for some time in sedimentation tanks. Figure 85 represents the relation of the river, the sedimentation tank, and the filtration bed to one another. Ninety-nine per cent. of the bacteria may be caught on top of the fine sand and held there until they are dead. When the topmost layer of sand becomes clogged with sediment, it is removed and fresh sand added from time to time. The rate of filtration is about 3,000,000 gallons per acre per day.

In the rapid mechanical filter, the water is first mixed with a solution of sulphate of iron or alum in order to

coagulate the impurities, and it is then passed rapidly through a layer of sand. The process is really one of straining the water. When the sand becomes clogged with bacteria and other impurities, the stream of water through the filter is reversed and the sand thoroughly washed. The rate of filtration is from 100 to 200 times more rapid than that of the slow sand filter.

Bleaching powder, called also chloride of lime, has come into very general use in recent years for disinfecting polluted water, whether from rivers or lakes. The bleaching powder may be added to the water as a paste, or chlorine gas may be passed directly into the water.

CHAPTER XLIII

LAKE WATER

The water from a large lake is no safer to drink than river water unless care is taken to prevent the pollution of the part that supplies the drinking-water. This was strikingly shown in yearly outbreaks of typhoid fever that took place in Kingston, Ontario, from 1889 to 1892. At that time the city derived its water supply from Lake Ontario. The intake pipe through which water was pumped all over the city ran out into the bay a distance of only 150 yards from the shore. Not far from the end of the suction pipe a large drain discharged sewage from the general hospital and from a number of private dwellings. Farther west, sewage from a large jail and from the hospital for the insane was emptied into the bay. It must be borne in mind, also, that the current which sets eastward past Kingston into

the St. Lawrence River is a very slow one. The water in the harbour might be looked upon as almost standing still. All these facts being considered, it will readily be seen that the water which was supplied to Kingston for some years could not have been good.

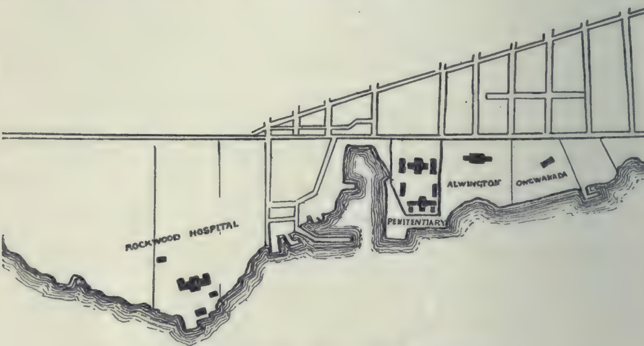


FIGURE 86.—Western end of Kingston Harbour.

The citizens became greatly alarmed when they learned that the discharges from typhoid fever patients were emptied into closets and passed thence through drains into the sluggish waters of the bay near the intake pipe. These discharges should have been made harmless by mixing them with chemicals, like chloride of lime or carbolic acid, so as to kill the germs; but this was not done. Only one result could follow; the germs were drawn up again from the bay in the suction pipe and spread all over the city in its drinking-water.

The citizens were warned not to drink the city water unless it were well boiled. But boiling the Kingston water was only a makeshift. The health of the citizens demanded that they should have pure water. They, therefore, had the intake pipe laid away out into the bay

over a mile from the shore, so as to extend quite beyond where the lake water was likely to be polluted with city sewage. As a result the annual outbreaks of typhoid fever ceased.

FIGURE 87.—Eastern end of Kingston Harbour.

Toronto, Cleveland, and Chicago have all had similar experiences to that of Kingston. In each of the three places, the city sewage was discharged directly into the lake or bay. This polluted the water of the bay, and when this polluted water was again drawn up in the water-pipes and distributed throughout the city as drinking water, there could hardly be any other result than a series of cases of typhoid and a high yearly death-rate.

Cleveland has solved its water-supply problem by putting its intake pipe five miles out into the lake, while Chicago has dug a drainage canal by which it discharges its sewage into the Mississippi River. It still gets its water supply from Lake Michigan, for the lake is not now polluted with the city sewage. Toronto and Kingston recently adopted the system of chlorinating their water supply, and thus practically banished typhoid fever.

The safest source of supply for large cities is a mountain stream or lake, as far away as possible from

human dwellings or any other probable source of pollution. Boston, New York, and Liverpool get their water from such sources.

A particularly pure water is that which comes from an artesian well. This differs from the ordinary surface well in the fact that it is sunk much deeper and usually through rock. Quite often the water rises up several feet above the level of the ground, showing that it has come from some higher locality, usually from a distant mountain. London, Ont., Brooklyn, N.Y., and Lowell, Mass., rely in part upon such wells for their water supply.

If people are in doubt regarding the quality of their water supply, they should send a sample for free examination to the laboratories of the Provincial Board of Health at Kingston, Toronto, or London.

CHAPTER XLIV

SEWAGE: GARBAGE

Sanitation has to do with the effects of a man's surroundings upon his health. Dusty or ill-smelling air, lack of sunshine, the presence of garbage, waste, ashes, tin cans, manure heaps, or other forms of filth may not of themselves cause disease. Their removal, however, will tend to make any neighbourhood more healthful, but will not necessarily make a community more healthy. As already shown, the cause of disease is usually something quite different from that of filthy surroundings.

As you know, waste matter leaves the body by the lungs, the skin, the kidneys, and the alimentary

tract. Only the waste from the two latter organs will be treated of in this chapter. The method of disposing of them will vary according as people live in villages and country districts or in towns and cities.

In villages and country districts, where there is no system of pipes supplying dwelling-houses with plenty of pure water and no system of drains to convey away the waste water from our houses, discharges from the kidneys and intestines are usually deposited in pits dug in the earth and covered with a small outhouse, the whole structure being known as a privy.

Disposal of fæcal matter, however, in the ordinary privy, is far from sanitary. In the first place, it is difficult to keep the pit closed against the entrance of flies, and, in the second place, the fæcal matter is usually allowed to accumulate for months and sometimes for years. The dry earth closet is a much more sanitary arrangement. Viewed from the outside, the privy and dry earth closet are much alike, but the latter has no pit, and the space beneath the seat is a rectangular wooden box with screened openings at each end. The fæcal matter is received into water-tight pails, which are placed under the seat and which

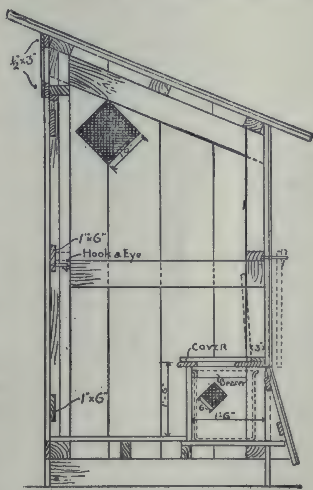


FIGURE 88.—Vertical front to back section through a dry earth closet.

can be readily removed through a small hinged door at the back. The material must be kept well covered with dry earth or ashes. The pails must be collected at frequent intervals, preferably daily, and a clean, empty pail substituted. It is best to bury the material in the ground in some suitable place, or burn it. The receiving pails should have tight lids, and every precaution should be taken to prevent the access of flies to the material. Such an outbuilding should not be situated near a well, certainly not nearer than fifty feet.

Sometimes where there is a supply of running water to a large house or to a public institution, but no drainage system, the septic tank is used as a means of disposing of fæcal matter. The septic tank is a large cement or metal tank sunk in the earth and covered with a close-fitting cover. Into this receptacle all fæcal matters are washed from the water-closet inside of the house, and retained therein until certain harmless bacteria have had time to reduce all the solid fæces to the liquid form. The inlet and outlet pipes to the tank are so adjusted that the contents are gradually drained away in underground pipes. If the liquid comes to the surface after treatment in a well-made septic tank, it is clear, odourless, and harmless.

Cesspools and privies were in use in the cities of Britain and America up to about 1850. Up to that time the city drains were used solely for carrying away waste water from dwelling-houses. Even up to 1880, Paris did not permit fæcal matter to be discharged into her public drains. At the present time the discharge of both waste water and fæcal matter into city drains is the universal practice. When drains are used for this double purpose,

they are spoken of as sewers and their contents as sewage. All cities and most towns have, then, a double set of underground pipes—one carrying pure water to the houses, and one carrying away waste water and fæcal matter.

FIGURE 89.—Water-tank, water-pipes, and sewer-pipes for a town. The water-pipes are shown as lying at a higher level than the sewer-pipes. Of course, both are underground in all towns and cities.

CHAPTER XLV

FURTHER EFFECTS OF ALCOHOL

Most people have noticed that a drunken man usually says foolish things and does foolish things. He thinks he can run farther, jump higher, work harder, write better, or count faster, with the aid of alcohol than without it. But this is all pure fancy. As to the use of his muscles, in either work or play, every one knows, who has ever

seen a drunken man, that, instead of being able to use his muscles properly, he can scarcely use them at all.

Scientific men, by a series of careful experiments, have learned beyond all question that alcohol—even a little of it—lessens a man's power of doing useful work. But, in addition to this scientific proof, there is the experience of men who employ large numbers of labourers. Such employers tell us that total abstainers do more work in a given time than an equal number of men who are moderate drinkers of alcohol, even though they may never get drunk.

Army officers tell us much the same thing about soldiers. Soldiers who are given no rations of whisky stand long marches and hard fighting better than soldiers who are supplied with alcohol. When we learn further that men who are being trained to take part in football, hockey, baseball, or rowing contests, are not allowed to drink alcohol or to smoke tobacco, we must conclude that the experience of their trainers has shown that these drugs do serious injury.

One of the most interesting tests of the effects of alcohol was that made upon skilled workmen by Dr. Aschaffenburg. Four experienced type-setters offered themselves for the experiment. Three of them were moderate drinkers, the fourth was known to drink excessively now and again. After first determining the men's average ability, by counting the actual number of letters which each man set in four periods of fifteen minutes each per day, they were directed to work on four successive days for periods of fifteen minutes each,

as in the preliminary tests. On the second and fourth days each man was to take three tablespoonfuls of alcohol, but none on the first and third.

All four men thought they were doing more work with the alcohol than without it, but the results shewed conclusively that the alcohol impaired every man's power of doing useful work.

A few years ago a noted scientist carried out a great many experiments with alcohol, the results of which go to show that, even in small doses, amounting to not more than a tablespoonful, alcohol lessens a man's power of doing mental work. For example, the speed and accuracy with which his students could add, subtract, multiply, and divide numbers in arithmetic were tested. They imagined that they could make arithmetical calculations more quickly with alcohol than without it, but the facts were exactly the reverse.

In one case a student was directed to add columns of figures for half-an-hour a day for six days. This was done in order to determine the average speed and accuracy with which he could work.

On the seventh day he began taking about two tablespoonfuls of alcohol, and continued this for thirteen days. His ability to add, in place of being maintained as it was on the sixth day, was at once decreased, and continued to decrease. On the nineteenth day the use of alcohol was stopped, when a gain in speed and accuracy at once became apparent.

Memory was tested by setting students to memorize columns of figures. It was found that 100 figures could

be remembered correctly after being repeated 40 times. But when alcohol was given it was found that only 60 figures could be remembered after being repeated 60 times.

Sweden was the first country to test the effects of alcohol upon quick and accurate rifle shooting. A number of officers and soldiers, all good shots, were directed to shoot at a target 200 yards distant. The tests were made several times a day, and on different days. When alcohol in doses of three tablespoonfuls was given, 30 per cent. fewer hits were made, although the men all thought they were shooting faster and more accurately with alcohol than without it.

Bad as are the effects of alcohol upon the drunkard himself, the effects upon his children are very much worse. They are often left without food, clothing, and education; but these are small ills compared with the supreme one which a drunkard sometimes brings upon his innocent offspring, namely, insanity.

The almost unvarying testimony of medical superintendents of lunatic asylums is that the drunkenness of fathers or mothers often entails upon children enfeebled brain and nerves, with the result that, when the strain and stress of adult life come upon them, brain and mind break down and they become inmates of lunatic asylums.

Dr. C. K. Clarke, formerly Medical Superintendent of the Toronto Hospital for the Insane, has stated, in one of his official reports, that in his opinion a large number of the patients in all lunatic asylums in

Canada either are the offspring of alcoholic parents or have become insane through drink.

In support of Dr. Clarke's views, it may be stated that of the 10,445 males and 10,852 females who were admitted into the insane asylums of England and Wales in 1906, about 22 per cent. of the male cases, and 9 per cent. of the female ones were caused by alcohol. These figures do not include those cases in which the insanity or mental breakdown was due to drunkenness in the parents. If such cases were taken into account, it would be found that fully 20 per cent. of all the cases of insanity in Britain are caused by alcohol.

That alcohol increases crime has long been known. In Sweden, between 1887 and 1897, no fewer than 17,374 persons were sentenced for crimes of various kinds. Of this number of crimes, about 71 per cent. were traceable to drink. In Massachusetts, U.S., from August, 1894, to August, 1895, 8,440 persons were sentenced for somewhat serious crimes, and of these 43 per cent. were committed while the criminal was under the influence of liquor. These facts show clearly that alcohol destroys self-control—the highest quality of the human mind.

Again, it is quite safe to say that the continued use of alcohol, even in moderate quantities, shortens life. No one knows this better than the chief physician of a life insurance company. The business of such a man is to give advice to the company about men whom it is safe to insure and about men whom it is not safe to insure. A man who wishes to get his life insured must first

answer a number of questions about himself, his father and mother, grandfather and grandmother, and brothers and sisters, if he has any. Then the doctor examines the man's heart, kidneys, lungs, and respiration. All the facts which the man himself gives and all those which the doctor finds out about the man's health, are written down and sent to the chief physician of the insurance company. Whether the company will insure the man's life or not will depend upon the advice of the chief physician. If the man uses alcohol even in moderate quantities, some companies will not take the risk; or, if they do, they charge a higher rate, because they say that such a man will not likely live so long as a man who does not take alcohol at all.

The following table indicates the expectation of life from the various ages indicated, as shown first by the "Hm." (healthy male) table, which was deduced by British Actuaries from the experience of the total business of a large number of British insurance companies, covering the years 1863-1893, and is regarded as one of the best standards in existence. The second, the "Tm." (temperance male) column, was deduced by Roderick Mackenzie Moore, an eminent British Actuary, from the experience of the United Kingdom Temperance and General Provident Institution of Great Britain, with regard to the lives of total abstainers during the years 1841-1891. The last column shows the per cent. of added years that come on the average to total abstainers according to the Hm. and Tm. columns.

YEARS OF EXPECTED LIFE

Age	Hm. Table	Tm. Table	Greater Average Life of Abstainers
20	41.56	46.95	12.97%
25	37.90	42.97	13.38%
35	30.52	34.59	13.23%
45	23.29	26.10	12.06%
55	16.46	18.13	10.14%
60	13.33	14.55	9.15%

The above is not a comparison of abstainers' lives with those of non-abstainers, but of abstainers' lives with the standards for well-selected lives generally, which are not classified.

The following table shows the experience of seven companies which classify their risks as total abstainers and general. The first four are British companies, the next is Australian, and the last two are Canadian:

PERCENTAGE OF EXPECTANCY

	Abstainers' Section	General Section	General Section Per Cent. of Abstainers	Years of Experience	
United Kingdom Temperance and General Provident.....	70.18%	91.90%	130.95%	52	1866-1917
Sceptre Life....	50.26	78.69	156.56	34	1884-1917
Scottish Temperance........	52.00	72.00	138.46	35	1883-1917
Abstainers and General*......	42.40	....	....	33	1884-1916
Temperance and General......	48.14	76.37	158.64	16	1901-1916
Manufacturers' Life..........	37.42	66.54	183.26	14	1902-1915
Equity Life*....	19.80	....	....	12	1904-1916

Column 3 shows the number of losses that occurred in the General Section in each company for each 100 that occurred in the Abstainers' Section.

* Business of these two companies was almost exclusively on the lives of abstainers.

A physician soon comes to know whether his patients are users of alcohol or not. He is compelled by law to report the cause of every death to a government official. In this way it has become known that steady drinkers, even though they may never have been drunk in their lives, are liable to suffer from certain diseases. For example, it has been observed that diseases of the heart, blood-vessels, stomach, kidneys, and liver are more common among such people than they are among total abstainers; and it has been noticed, also, that the use of alcohol makes some diseases, such as indigestion and gout, much worse than they would otherwise be.

The conclusion from all this is obvious: alcohol is a very dangerous drug; its continued use soon passes into a habit which enslaves and destroys both mind and body; and, therefore, the only safe rule to follow regarding it is to avoid its use altogether.

CHAPTER XLVI

NARCOTICS: OPIUM, TOBACCO, COCAINE

A narcotic is a substance which either puts one asleep or at least benumbs the nervous system and prevents its healthy action. Alcohol, ether, chloroform, bromide of potash, chloral hydrate, cocaine, opium and an extract from it called morphia, are narcotics. Used in small quantities, they seem to excite the nerves and stir up the machinery of the body just as tea and coffee do; but they are not really stimulants.

When taken in larger quantities, they dull the nerves and, finally, put a man into a deep sleep such as we often see in the drunkard. You will, of course, understand that they do not act upon all of us to the same extent when taken in equally large or small doses.

Ether and chloroform are liquids which rapidly turn into an invisible vapour. Taken into the body through the lungs along with the air which we breathe, they produce the profound sleep into which people are thrown before they undergo a serious surgical operation.

Ether, alcohol, and chloroform resemble one another in another respect; they make those who take them believe that they are stronger, quicker, and more able to do things with the aid of the drug than without it. How groundless this belief is in the case of alcohol has already been shown.

These three drugs also reduce the body temperature below the point at which it stands in good health. For this reason a person who has undergone any surgical operation under ether or chloroform is afterwards kept in bed for a time with hot-water bottles about his body.

Alcohol, also, in large doses, produces the deep sleep of the drunkard. So too, bromide of potash, opium, and some substances which are made from coal tar, possess this same numbing and deadening effect. The nicotine of tobacco in the minute doses in which it gets into the body in smoking, rarely does more than soothe or dull nervous sensibility; nevertheless it also belongs to the class of narcotics.

Lastly, all the drugs of this class create a strong and often uncontrollable desire to take more of them, until at last the drug habit is developed, and then health speedily becomes ruined and life prospects blighted.

In this chapter we shall consider briefly the effects of only three of the narcotics—opium, cocaine, and tobacco. Opium and its extract, morphine, are among the most useful of drugs, for they deaden the nerves and relieve great pain when perhaps nothing else will. But the drug should be used with great caution and only under the advice of a physician. It should never be used as a remedy for sleeplessness. An uncontrollable craving for it comes on much sooner than for alcohol. It is, therefore, just so much the more dangerous.

Chloral and cocaine resemble opium somewhat in their effects. Chloral is sometimes used to make people sleep, and cocaine is often forced into the flesh to deaden pain, when the surgeon is about to perform some slight but painful operation.

Perhaps the greatest danger of acquiring the cocaine habit comes from using the drug in the form of an ointment for rubbing into the nostrils, when a person is suffering from nasal catarrh, a disease which usually comes on as the result of a succession of colds in the nose. When this disease has lasted for a long time, it becomes very trying to the health. A man is thus greatly tempted to use such an ointment, and almost before he knows of the danger, he has acquired the cocaine habit. Whether rubbed into the nose or taken in some kind of drink, the habit, once it is formed, is very difficult to break off.

No doubt some medical men have been much too careless in the past in advising people to take alcohol, opium, chloral, and other narcotics. The use of these medicines under the direction of a wise physician for a very short time is right; but the danger of becoming a slave to their use is so great that both physician and patient should always be on their guard. Many of the diseases for which these drugs are given, if curable at all, can be cured only by a surgical operation or by practising a healthful mode of living.

When we come to consider tobacco, we have to do with a drug that, in some respects, is unlike the others that have been mentioned. In the first place, its use does not produce the same evil effects upon mind and morals; and, though men do become slaves to it, and though its use in some cases impairs digestion, injures the throat, upsets the regular beat of the heart, and weakens the nervous system, yet in many other cases no evil consequences appear to follow from using it.

While it cannot be proved that the practice of smoking tobacco stunts the growth of boys, so far as mere size is concerned, we do know that its effects fall pretty heavily upon their brain and spinal cord. It prevents the nerves from growing as strong as they should, and this means, in the end, a more delicate body. The effects upon the nerves may easily be noticed in the trembling of the hand in boys who smoke much, especially if they inhale the smoke; that is, pass it down into the throat. When smoking is carried on in this latter way, more of the poison of the tobacco, "nicotine", is passed into the body, and it produces a more marked effect upon the nerves. Employers of

labour have frequently noticed that young men who smoke many cigarettes are forgetful and are less reliable in their work than non-smokers.

The question of whether you will use tobacco or not is a very serious one. Before you decide to use it, you should try to think of its effects upon others as well as upon yourselves. Its bad effects upon other people in the same house is often overlooked. Tobacco smoke in houses is hurtful to young children, and a great annoyance to those who do not smoke. If several men are smoking in a small room, the air soon becomes quite unfit for anyone to breathe. Much less is it fit for a delicate person or a child to live in. So that, if any of you should determine to become smokers, knowing all the time the risk to your own health, you ought at least to pay some attention, while indulging the habit, to the health and feelings of others. No person has a right to spoil the air which others have to breathe.

Does tobacco smoking hurt a grown-up man? Yes; it does in some cases, unless the man is very robust. It is impossible to prove that smoking hurts a strong, healthy man who is living a regular outdoor life. But, in the case of men who have not been born strong, who live an indoor life, and who do not take much exercise, there can be no reasonable doubt that smoking tends in time to undermine the health. Many men have found this out for themselves. Some when upwards of forty years of age, have succeeded, by great effort, in giving up the habit. How much better if they had never learned it!

CHAPTER XLVII

FAMILY STOCK

You know how particular many farmers are about the breed of their cattle, horses, and dogs. They are proud of their Jersey cows, their Percheron horses, or their Collie dogs, and they take the greatest pains to keep the race as purely bred as possible. And, in somewhat the same way, there are many parents to-day who are most anxious that their sons and daughters should make proper marriages. With them it is not a question of marrying into a wealthy family; but it is a question of soundness of body, purity of life, and purity of morals.

The large mass of the population of America belong to a good sound stock; but there is, also, in every district a certain number of families who are weaklings or are diseased in body and impure and depraved in mind and life.

In order to make the difference between two such families as clear as possible, there is laid before you a very brief history of a bad family—the Juke, and an equally brief history of a good family—the Edwards, the latter having amongst its members the celebrated divine and philosopher, Jonathan Edwards.

It is to the late Mr. Richard Dugdale that we are indebted for the history of the notorious Juke family. His special purpose in studying its members was to find out, if possible, whether or not criminal parents usually have criminal children, and whether such children, on becoming men and women and marrying, have criminal children. In other words, he wished to know whether

crime and pauperism run in families from father to son throughout a number of generations.

After years of patient toil in gathering the facts about these people and their immediate relatives, Mr. Dugdale came to realize that they had all sprung from a long line of ancestors reaching back to the early days of the settlement of the state. The forefather of the family on the father's side was born between the years 1720 and 1740, and was called Max. This Max was descended from early Dutch settlers and lived much as our backwoodsmen do to-day in remote settlements. In old age, he became blind from a disease which was passed on to his children and grandchildren. He had a large family. Two of his five sons married two out of six sisters who were the female ancestors of the Juke family.

The Juke sisters were born between the years 1740 and 1760. One of the six, known as Ada Juke, though this was not her real name, left one son, who became the father of a line of descendants, many of whom were criminals through five generations. For this reason she has long been known to the police as "Margaret, the mother of criminals". The fifth sister was the mother of a line of descendants, most of whom, in place of being criminals as in the case of Ada's children, were paupers; that is, they were never able to earn enough money to keep themselves in food, shelter, and clothing.

It is impossible to state the particulars about the drunkenness, vagrancy, pauperism, licentiousness, disease, and crime of the Juke family. The number of descendants whose records have been traced reaches 540 persons—all related by blood to the Jukes. The

number related to them by marriage is 169, or 709 persons in all, alive and dead. But it is quite certain that there are about 500 others who are related to the Jukes but whose relationship it has not been possible to trace on account of their migrations from place to place.

After drawing up a statement of the loss in labour and wages and the cost of supporting the family at the public expense, Mr. Dugdale says: "Over a million and a quarter dollars of loss in 75 years caused by a single family 1,200 strong, without reckoning the cash paid for whisky, or taking into account the entailment of pauperism and crime on the survivors in succeeding generations, and the incurable disease, idiocy, and insanity growing out of this debauchery and reaching further than we can calculate. It is getting to be time to ask, do our courts, our laws, our almhouses, and our jails deal with the question presented?"

It is scarcely possible to conceive of a greater contrast between two families than that between the Jukes and the Edwards. In one group there was scarcely a strain of industry, scholarship, or virtue. They were ignorant, profane, licentious, idle paupers and criminals. In the other group, you find ability, character, high purpose in life, and magnificent achievement. Max and Edwards were both country lads. Both lived on the frontier, and were, therefore, far removed from the opportunity of getting either a High School or a College education. Looking back from this distance of time, one would naturally think that each man had an equal chance for success in life. But he had not. Their own lives and that of their children show most

clearly how the blessing of a good heredity, or the curse of a bad one, handicaps a family stock for generations. Max, as we have seen, gave 1,200 descendants to the world, noted chiefly for their licentiousness, pauperism, and crime; while Edwards has become the ancestor of some 1,400 men and women, distinguished, all over the United States and Canada, for their virtue, honesty, earnestness, nobility, and high achievements. Not one of Max's 1,200 descendants ever secured even a High School education. They all lacked the inherited capacity or training without which all high achievement is impossible. Only 20 of the Jukes ever learned a trade, and then only in the state prison.

On the other hand, the Edwards family inherited great capacity for training. No fewer than 285 of the descendants were college graduates. Thirteen of these became college presidents. Sixty-five are college professors, many are principals of High Schools and Academies, and many others are prominent in business and professional life.

If you have followed the teachings of this book thus far, it must be clear to you now that our lives, from birth until old age, are shaped largely by two great influences: (1) by what we inherit from parents, grandparents, or other ancestral relatives, and (2) by our environment, that is, by our surroundings.

Our lives are being moulded every day we live by our environment—by the air and light about us, the food we eat, the liquids we drink, the clothing we wear, the houses we live in, the earth we walk on or dig in, the water we bathe in, the people we associate with in schools and

churches, the sights we see at home or when we travel. All these affect us more or less throughout life. Environment and heredity—these are the two factors that largely mould human life.

As illustrating how potent these factors are, I need only remind you of the high death-rate among infants in Ontario in 1917. Out of 62,666 babies born in that year, no fewer than 8,263 died before they were one year old. When we look into the causes of death, we find that about 2,500 were dead at birth, and that about 2,000 other deaths are reported as due to diseases of early infancy; in other words, 4,500 infants died because of a defective heredity. We may assume that probably 800 more must have died from the same cause, though this is not clearly stated in the reports of the government.

Deducting the number who thus died because of their defective heredity from the total of 8,263, would leave about 3,000 who died because of the unfavourable environment into which they were born. Looking into the cause of the death of these 3,000, we find that about half of them are reported as dying of diarrhœa, indigestion, or inflammation of the intestines; and about half as dying of diseases of the air-passages, like pneumonia and bronchitis. Every physician knows that many of such deaths are preventable. It is safe to say that the lives of 2,000 babies could be saved annually, if parents were only sufficiently intelligent or sufficiently trained to care properly for their offspring.

If parents take good care of their children, giving them plenty of good food, that is, milk, eggs, fruits,

vegetables, bread, butter, soups, and easily digested meats, sending them to play much and often in the sunshine and fresh air; providing them with clean, warm clothing in winter and light, cool clothing in summer; and seeing that they get enough sleep; many more of them than at present are likely to grow up with sound minds and sound bodies.

Almost the whole of this book is devoted to an attempt to show how our environment influences our health, happiness, and success in life. Little has been said about heredity; but the heredity of the Juke family has been dealt with for the purpose of placing you on your guard against selecting for a life partner a member of a tainted family.

We all come into the world stamped with a certain quality of blood, brawn, and brain, and quite unable to make geniuses out of ourselves if we have been born weaklings in mind. A Juke cannot change himself into a Jonathan Edwards. But a man may hope, by the exercise of his will and reason, to dominate even an unfavourable environment and heredity and to command a considerable measure of success in life.

CHAPTER XLVIII

EMERGENCIES

In case of an accident, every boy and girl should know what to do before the doctor comes. A boy who is quick to think and quick to act may often be of great service to one who is bleeding profusely, or who has taken poison, or who is unconscious and almost dead from being under water.

Drowning

When taken from the water, a person should first be turned face downward and held up by the middle with his head low, in order to allow the water to run out of his mouth and lungs. Loosen the collar quickly, but do not take time to remove the clothing. If respiration has ceased, artificial respiration must be commenced at once; every instant of delay is serious. To do this, the patient should be placed upon his back, with a block of wood or a folded coat under his back. Then one person should raise the patient's arms horizontally above his head and lower them again to his sides. As the patient's arms reach his sides, another person should press upon his stomach and the edge of his chest, so as to diminish the size of the chest and aid in the expulsion of air. These movements should be continued at the rate of about seventeen per minute. Efforts at resuscitation should be kept up for an hour, or even longer. During this time others may apply warmth to the body by means of hot flannels, hot-water bottles, etc.

Figures 90, 91, and 92 show how artificial respiration can be carried on by one person. Pupils should practise it on one another.

Another Method

Two objections have often been urged against keeping the patient lying upon his back while carrying on artificial respiration. The first is that the tongue may slip backward and close the entrance to the windpipe. The second objection is that the water, mucus, and froth in the windpipe prevent the free entrance of the air.

FIGURE 90.

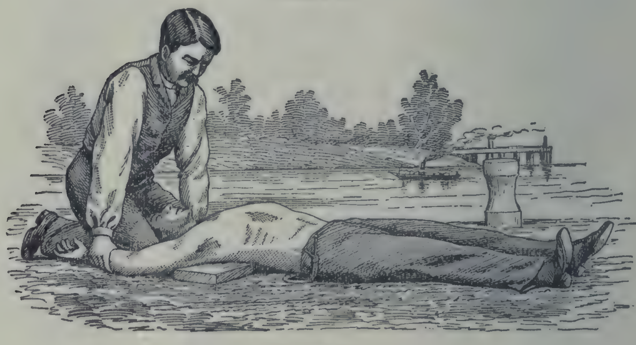


FIGURE 91.

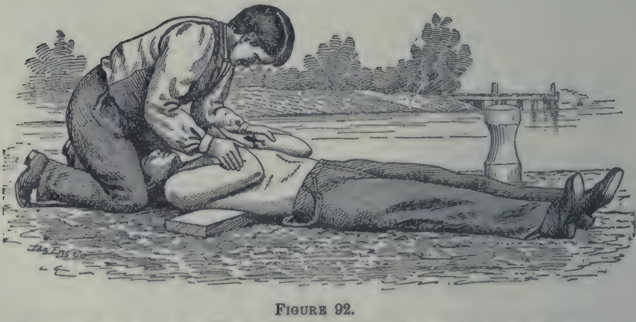


FIGURE 92.

FIGURES 90, 91, and 92.—How artificial respiration is carried on by one person.

Professor Schäfer of Edinburgh University, therefore, advises that the patient be placed "face downwards on the ground with a folded coat under the lower part of the chest".

FIGURE 93.

FIGURE 94.

"To effect artificial respiration", he says, "put yourself on one side of the patient's body; or astride of it, supporting yourself on one knee upon one side, and on one foot on the other side. Place your hands flat over the

lower part of the back (on the lowest ribs), one on each side, and gradually throw the weight of your body forward on to them so as to produce firm pressure—which must not be violent—upon the patient's chest. By this means air (and water if there is any) is driven out of the patient's lungs. Immediately thereafter raise your body so as to remove the pressure, but having your hands in position. Repeat this forward and backward movement (pressure and relaxation of pressure) every four or five seconds. In other words, sway your body forwards and backwards upon your arms fifteen or twenty times a minute without any marked pause between the movements. This course must be pursued for at least half-an-hour, or until the natural respirations are resumed".

"Whilst one person is carrying out artificial respiration in this way, others may, if there be opportunity, busy themselves with applying hot flannels to the body and limbs and hot bottles to the feet". After natural respiration has begun, massage should be applied to the limbs.

Bleeding or Hemorrhage

If a large artery or vein in a limb is cut, a physician should be summoned at once. The rapid flow of blood

Figure 95.—Tourniquet or bandage twisted tight with a stick.

from a large vessel prevents clotting. In these circumstances, the limb should at once be grasped firmly with the hands and pressure applied above the wound (nearer to the heart) if it is an artery, and below the wound (nearer the hand or foot) if it is a vein. While pressure is being thus maintained upon the artery or the vein, a strong handkerchief or cord should be tied loosely round the limb and a stick run below the handkerchief and twisted so as to bring great pressure to bear upon the bleeding vessels. This will stop the most profuse bleeding in any limb.

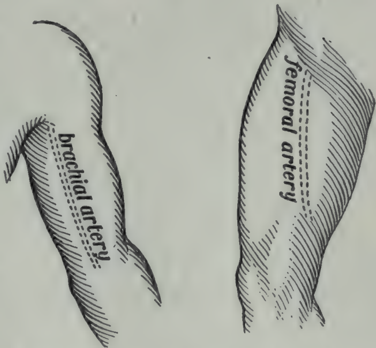


FIGURE 96.—Brachial and femoral arteries.

If, however, no large blood-vessel has been cut, it is important to know what to do in order to help the blood to clot. Perhaps the best thing is to apply hot water to the injured part. The water should be as hot as can be borne. The heat makes the small vessels shrink in diameter, and this, along with the clot which forms, soon stops the bleeding. If the bleeding cannot be stopped in this way, place a firm pad of clean cotton upon the wound and then tie a bandage tightly around it.

If the wound has been made with a dirty knife, tin can, rusty nail, or glass, it should be thoroughly washed with clean, boiled water before being bandaged. In

such wounds, especially if any soil has been carried deeply into the wound, or if the wound is of such a character that it cannot be thoroughly washed out, there is danger of the development of lock-jaw. Tetanus (lock-jaw) antitoxin should be given in all such cases by your doctor. This antitoxin is supplied by the Provincial Government free of charge.

Fainting

Fainting is usually caused by the blood-flow to the brain being cut off or very much reduced. Consequently, the first thing to be done in order to restore consciousness is to promote the return of the blood to the brain. This is usually done by lowering the head and raising the legs and feet. In addition, the clothing should be loosened around the neck and chest, fresh air admitted to the room, and a touch of cold water applied to the face.

Strong ammonia or smelling salts should not be held to the nose of a person who is in a faint. It is very irritating and, as a rule, does no good.

Dislocation

If bones are forced out of their natural position in a joint, they are said to be "dislocated". When bones are thus dislocated, some of the ligaments may be broken, and the bones must be put back again along the same course by which they came out. In simple dislocations of the fingers or wrists, the bones can generally be returned to their natural position by pulling on the joint and pressing the bones back into their place.

A sprain is a tear or strain of the ligaments of a joint, but without dislocation of the bones. A tear is much

more serious than a strain. In either case, the joint should be bathed thoroughly in water as hot as it can be borne for ten or fifteen minutes. This should be accompanied with brisk rubbing of the joint. Then the joint should be rested for some time according to the extent of the injury.

Fractures

In all fractures of bone, the chief thing to do before a surgeon can be secured is to keep the limb or broken part at rest. If the patient has to be moved some distance to his home or to a hospital, he should be carried upon a door, shutter, or board. Before doing this, however, the limb should be tied to a thin piece of straight wood, so that it cannot move. Or an umbrella or walking-stick may be used, or the two legs, in case of one being broken, may be tied together. Handkerchiefs make good temporary bandages. When necessary, clothes should be removed by opening them along the seams.

Figure 97. — Temporary splint and bandage on a broken leg. Enough bandages should be applied to prevent movement of the limb.

Sunstroke

The main symptom of sunstroke, or heatstroke, as it is sometimes called, is the high temperature. A clinical or other small thermometer placed in the mouth shows a temperature varying between 105° F. and 112° F. Consequently, the first thing to do is to place the patient in a

cold bath; ice, if convenient, being applied to the head and body. The cold water treatment must be continued until the temperature falls to the normal.

Heat Exhaustion

This is a condition that is closely related to heat-stroke, but is not so severe, and is not at first accompanied by any elevation of body temperature. Later on there is some fever. First aid consists in keeping the patient very quiet and giving stimulating drinks.

Burns and Scalds

When a girl's clothes are on fire she should never run about. This only fans the flame. She should be forced to lie down, so that the flames may not rise round her head and neck, where they do most injury. If a bucket of water is at hand it should be dashed over her. If not, woollen clothes, such as a blanket, rug, shawl, or overcoat should be wrapped round her body to extinguish the flames.

The emergent treatment of scalds is much the same as that for burns. Clothing should be removed by cutting, or opening along the seams. A warm bath of 100° F. or hot-water bottles around the body, a stimulant of hot coffee, and perhaps a mustard plaster over the heart, will all contribute to overcome the great prostration that always follows a severe burn or scald. The burned or scalded part is best treated by spraying it with melted paraffin by means of an atomizer that is immersed in water warm enough to keep the paraffin in a melted condition. Care must be taken that the paraffin is not warmer than blood heat. It is an

advantage to cover the burned part with a thin layer of absorbent cotton or gauze, before applying the paraffin spray.

Poisons

When common household poisons, such as paris green, fly poisons, corrosive sublimate (which is often used as a disinfectant), paregoric, soothing syrup, ends of matches, are taken by accident, the first thing to do is to send for a physician. While awaiting his arrival, however, it is generally advisable to induce vomiting. This may be done by giving a teaspoonful of mustard in a glass of warm water. Repeat the dose in about ten minutes, if the first produces no effect.

After the emetic, the following antidotes may be given to counteract the effects of any of the poison which may remain in the body:

1. For any kind of lead poisoning (sugar of lead, or white lead), give a large dose of Epsom salts or Glauber's salts.

2. For corrosive sublimate, solution of bluestone, or verdigris, give the whites of several eggs, or large quantities of flour and water.

3. For opium poisoning (paregoric, soothing syrup, laudanum), keep the patient walking about and give frequent drinks of strong coffee.

4. For strychnia poisoning, administer ether or chloroform to relieve the muscular spasms. If the respiration stops, keep up artificial respiration.

5. In arsenic poisoning (paris green or fly poisons), mix tincture of iron with baking-soda, and give the patient every minute or two a teaspoonful of the brownish powder that forms.

6. For poisoning with matches, give the whites of several eggs, or a dessertspoonful of powdered charcoal.

For acid poisons, such as nitric, sulphuric, carbolic, or muriatic acid, give at once, without producing vomiting, three or four spoonfuls of baking-soda dissolved in water, or a glass or two of lime-water.

Convulsions

When in convulsions, or fits, a person should be placed where he will not strike his arms or legs against anything hard. Often the patient foams at his mouth and grinds his teeth. To prevent him from biting his tongue, a spoon or lead-pencil with a handkerchief wound round it should be inserted between his teeth.

Frost-bites

The part which has become frost-bitten should be covered with a muffler or gently rubbed with fur. It should not be bathed with warm water. Nor should the patient be sent into a warm room. Gentle rubbing with snow, or bathing the part in ice-cold water are also suitable remedies.

Electric Shock

If the body is in contact with a "live wire", it should be removed from the wire by using a dry stick, or a dry piece of clothing. Do not use your bare hands to move the body, or you may be injured yourself. If breathing has ceased, perform artificial respiration at once and keep it up for at least half-an-hour.

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